M1000 Series
Signal Conditioning
System User Guide

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SECTION 1 - INTRODUCTION

This manual has been produced to allow the User to make full use of the Micro Movements M1000 Series Signal Conditioning System. It is not intended that the User should undertake major maintenance, for which the System should be returned to Micro Movements. Consequently some of the technical descriptions and maintenance procedures are not explained in full.

For further details on Maintenance and Fault Finding please refer to the Service Manual.

This manual is divided into 3 main sections, which cover:

Description

Set Up

Operation

WARNING

HEALTH AND SAFETY AT WORK

MICRO MOVEMENTS LIMITED HAVE ENSURED THAT, AS FAR AS PRACTICABLE, ANY PERSON CARRYING OUT NORMAL MAINTENANCE OPERATIONS ON THE ABOVE SYSTEM IS NOT EXPOSED TO ANY UNDUE HAZARD FROM ELECTRIC SHOCK OR PERSONAL INJURY.

HOWEVER, MAINTENANCE AND/OR SERVICING OPERATIONS MAY INVOLVE REMOVAL OF COVERS OR DISASSEMBLY OF COMPONENTS. UNDER SUCH CONDITIONS THE INTEGRITY OF THE EQUIPMENT MAY BE IMPAIRED. **MICRO MOVEMENTS** THEREFORE RECOMMEND THAT MAINTENANCE IS ONLY CARRIED OUT BY A COMPETENT PERSON OR PERSONS CONVERSANT WITH THE HAZARDS OF WORKING WITH ELECTRO-MECHANICAL SYSTEMS.

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SECTION 2 - DESCRIPTION

2.1 General Description

The M1000 series signal conditioning cabinets are multi-channel systems that can accept signals from most types of transducers. These are conditioned, amplified and matched to drive tape recorders, lightbeam recorders, computers, etc. The following features are included in all systems:

- Power supplies for all the transducers
- Configuration switches, e.g. full, half or quarter bridge
- Individual gain and balance controls
- A digital monitor with channel selector
- An accurate calibration facility.

2.1.1 Signal Conditioning Cabinets

Four cabinets types are available:

- **M1000-6**

  The M1000-6 is a self contained compact unit primarily intended for mobile applications. It can house up to 6 channels of Micro Movements Signal Conditioning Amplifiers.

- **M1000-12**

  The M1000-12 has similar facilities as the M1000-6 but with a maximum channel capacity of 12. The M1000-12/P is similar but also has a post-conditioning facility; i.e. filter, power amplifiers, etc. can be plugged into the top of the cabinet.

- **M1000-16**

  The M1000-16 and -16/P have similar facilities to the M1000-12 and -12/P respectively but with a maximum channel capacity of 16.

- **M1000-24**

  The M1000-24 and -24/P have similar facilities to the M1000-16 and -16/P respectively but with a maximum channel capacity of 24.

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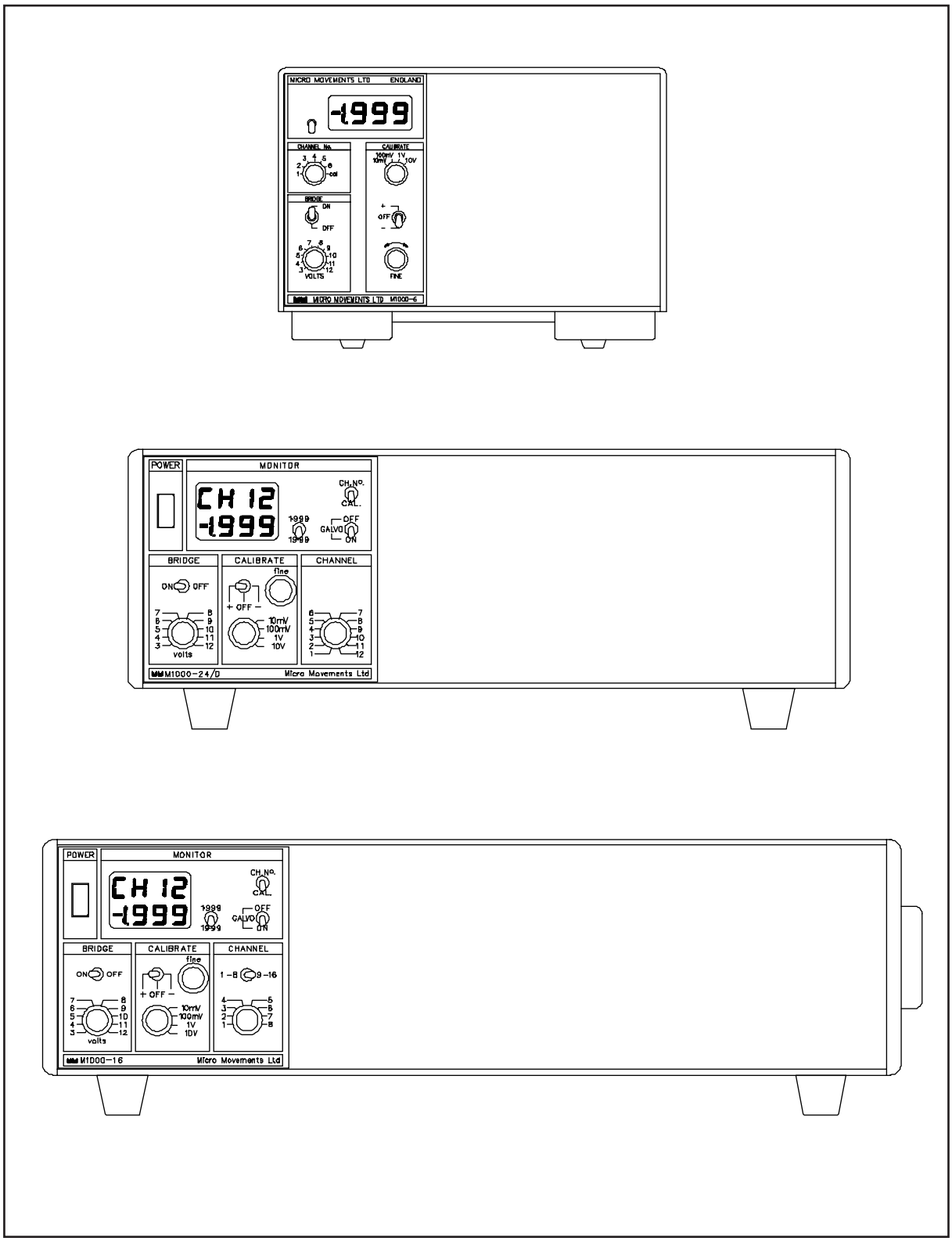

Figure 2-1 M1000-6 , M1000-12 and M1000-16 Front Panels

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2.1.2 Signal Conditioning

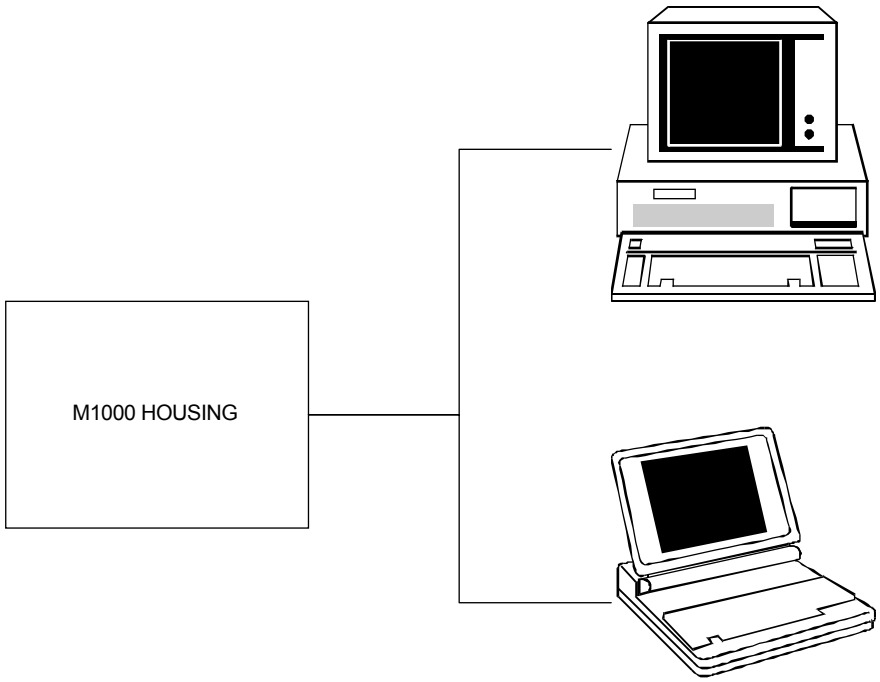
Standard plug-in modules are available to condition Pressure, Temperature, Acceleration and Flow transducers, etc. Also available is a wide range of modules that have been designed for special customer requirements (see section 2.4).

2.2 Applications

The cabinets have been designed to be used as stand alone units. In this mode they are used to drive tape recorders, data loggers, computers or other data storage equipment.

The cabinets also have facilities to drive Micro Movements M300H Lightbeam Recorders and all the matching circuits for the galvanometers are included in the modules. Direct interconnection cables are available from the M1000 to the M300H recorder.

The M1000 series housings have been particularly designed to interface with DATA ACQUISITION SYSTEMS. The voltage output connector on the rear of the housing can be connected directly to a PC based data acquisition card, either ISA or PCMCIA. Micro Movements can provide complete data acquisition systems or advice on integration with an existing system.



2.3 Specifications

Signal Input

7 pin lockable DIN connector, one for each channel

Power Supply

115/230V 45-440Hz, selectable via rear panel control

12/24VDC

Power Consumption

M1000-6	20VA maximum
M1000-12	25VA maximum
M1000-16	28VA maximum
M1000-24	30VA maximum

Operating Temperature

0°C to 40°C

Storage Temperature

-20°C to +70°C

Digital Monitor

3 1/2 digits

Range 1 - 1.999 volts

Range 2 - 19.99 volts

Dual range LED display shows channel number, calibration input and voltage output for each channel.

Calibration

±1mV through ±10 V continuously variable (Four switched attenuator ranges and Fine interpolation control).

Attenuator accuracy - 0.5%

Stability - 200 p.p.m./°C

Transducer Power Supply

3-12 VDC in 1V steps

Output Conditioning

-12/P, -16/P and -24/P model cabinets have an output conditioning section below a hinged panel on the top cover. Each slot must be filled with either a module or an M1088-P channel completion module to route the voltage and current outputs to the rear panel.

Signal Outputs (VOLTAGE)

	M1000-6	M1000-12	M1000-16	M1000-24
Standard	15 Pin D	15 Pin D	25 Pin D	25 Pin D
Optional	BNC	BNC	BNC	BNC
Special	As required subject to space limitations			

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2.4 Signal Conditioning Modules

The following signal conditioning modules are available for use with the M1000 Series.

M1020 Designers Module

A matrix-pattern printed circuit card contained within a standard amplifier module which enables non-standard circuits, “specials”, etc. to be utilised within the system. Input, output, power supplies, calibration, etc. are all accessed via the module connector.

M1049 Oscillator/Amplifier/Demodulator/Filter

For energising and conditioning of variable reluctance transducers, differential transformers, AC-excited LVDTs, etc. With built-in continuously variable, stored calibration facility. Separately controlled buffered voltage output to drive data storage equipment.

M1055 Passive Conditioner

Universal module with bridge balance, span adjust and shunt calibration controls, for resistive transducers. Range adjustable by resistor-change to match most inputs to low-frequency galvanometers.

M1060 High Gain DC Amplifier

Differential Amplifier for use with most types of low-level transducers, e.g. strain gauges in 1, 2, or 4 active arm configuration, bonded and unbonded strain gauge transducers and load cells. Separately controlled buffered output to drive data storage equipment.

M1061 Thermocouple Amplifier

For use with thermocouples and similar low-level devices. Full scale output for 1mV to 100mV input. Separately controlled buffered voltage output to drive tape recorders, etc.

C1061/R Connector

Special connector with integral cold junction compensation for above.

M1070 Attenuator/Amplifier

General purpose unit for medium to high level inputs, e.g. potentiometric transducers, DC/DC LVDTs, servo accelerometers, tape replay amplifiers. Separately controlled buffered voltage output to drive data storage equipment.

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C1070/H Adaptor

High impedance adaptor, for operation of M1070 with piezo-electric sensors or signals with very high source impedance.

M1071 Variable Attenuator

Resistive network to provide attenuation, matching and damping between high level inputs and most types of galvanometer. Separately controlled buffered voltage output to drive tape recorders, etc.

C103 High Voltage Connector

With 60dB balanced attenuator network for measuring high input voltages (up to 500V RMS).

C104 High Voltage Connector

With 80dB balanced attenuator network for measuring high input voltages (up to 500V RMS).

C/NA Shunt Connector

For current measurement (N specifies the current). Range 0.1 to 10 amps.

M1073 RMS/DC Converter

Precision rectifier unit for monitoring amplitude changes in AC waveforms. Includes separate buffered voltage output for tape recording, etc.

M1080 Frequency/DC Converter

For use with impeller flowmeters, magnetic or photo-electric RPM pickups, tachometers, vibration pickups. Separately controlled buffered voltage output to drive data storage equipment.

M1085 Oscillator Module

Nine calibrated ranges from 20Hz to 10kHz (crystal controlled), for calibration of M1080.

M1090 Series Filters

A range of filters is available from 2 to 6 pole with Butterworth, Bessel or Chebyshev characteristic.

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2.5 Output Conditioning Modules

The M1000-12/P, -16/P, -24/P instruments are provided with an Output Conditioning Stage which is accessible through the hatch at the top of the unit. If this section is not used, the connections are normally linked through with M1088-P Channel Completion Cards. The links are:

9 - 10	Output Common
7 - 12	Voltage Output
8 - 11	Current Output

A number of output conditioning units are available:

M1072-P Power Output Amplifier (Current Output)

A power amplifier option is available with the following possible outputs:

Current Output:	±10mA into 500 ohms max.
Galvo. Drive Amplifier:	±50mA into 42 ohms max.

M1090 Active Filters

Low Pass Active Filters are available. The type numbers of the filters are given as follows:

M1090-02-* 2 pole Low pass

M1090-04-* 4 pole Low pass

M1090-06-* 6 pole Low pass

M1090-04/2-*/* 4 pole Low pass, 2 selectable cut-off frequencies

M1090-04/3-*/*/* 4 pole Low pass, 3 selectable cut-off frequencies

* = Cut-off frequency (-3dB)

Note: On the 04/2 and 04/3 selectable frequency versions, the maximum range of frequencies on any individual PCB is 20:1

Normally filters are supplied with Butterworth characteristics unless otherwise specified. Bessel, Chebychev or Paynter can be characterised at no extra cost.

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Number of Poles

The printed circuit board (type 'P') filters are available as 2, 4 or 6 poles. The two pole units have two independent filters, one for the current and one for the voltage outputs. The four pole filters can be on either the voltage or the current outputs but not on both. The non-filtered output is connected directly.

Both the two and four pole filters are available with an output reversing switch.

The 6 pole filter can be fitted to either the current or voltage output but not both. This filter is a unity gain type and is fitted with a bypass switch ('Filter On/Off').

Construction

The suffix P denotes that the filter is a PCB and is fitted into the output stage of the amplifier cabinet.

Cut-Off Frequency "fc"

The Cut-Off Frequency is factory preset and for the Butterworth filter the amplitude is 3dB down at "fc". For the Bessel and Chebychev filters the application should be discussed with the Company.

Changing the Cut-Off Frequency

The M1090 Series Filters are designed with "Equal Value" filter components to facilitate the change of Cut-Off Frequency. The Cut-Off Frequency can be reduced by either increasing the filter capacitors or alternatively increasing the two filter resistors.

M1090/4-20 4to 20 mA converter

Special plug-in card that translates the normal 0-10v signal (or optionally the -10 to +10) into a 4 to 20 milliamp signal which is available on the 'Galvo' output connector at the rear of the housing.

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SECTION 3 - SET-UP

3.1 Installation

The M1000 Series Signal Conditioning System cabinets are portable and therefore not dedicated to one installation point. During use there are some simple precautions to follow if the system is to operate safely and correctly.

a) Supply voltage

Before connecting the cabinet to the power supply, check that the voltage has been set to the correct position for the local supply voltage and that the appropriate fuse has been fitted. The supply voltage is selected by means of a rotary switch located on the rear panel of the cabinet.

b) The top cover should not be removed except by qualified personnel.

c) It is essential that the air vents around the cabinet are not blocked while it is in operation, as adequate ventilation is required to prevent overheating.

The following items are supplied with each cabinet:

- 1 Mains power lead with moulded socket.
- 1 x 7 pin locking DIN connector. One further connector is supplied with each signal conditioning amplifier ordered with the mainframe.
- 1 set of manuals.

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3.2 Preparing for use

3.2.1 Basic set up

a) Ensure the power switch is in the OFF position (located on the rear panel on the M1000-6).

b) Select the voltage of the power source using a screwdriver on the rear panel selector. The settings are:

DC - 12V and 24V

AC - 115V and 230V, 45 - 400 Hz

c) Connect the power source to the appropriate socket on the rear panel. In the case of the M1000-12, -16 and -24 the left hand 4 pin socket is for the DC supply, the right hand 3 pin socket for the AC supply. The M1000-6 has a smaller 2 pin socket for the DC supply located above the 3 pin AC socket.

d) Connect the 7 pin connectors to the signal input connectors (see section 3.3 for connection details).

e) Connect the D-type output connectors to the voltage and current output sockets (see section 3.3 for connection details).

3.2.2 Operating Controls

Set the operating controls on the front panel to suit the requirement (see section 4 for the use of controls).

3.2.3 Switching on

Set the power switch to the ON position (located on the rear panel of the M1000-6). The system should now be ready for use.

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3.3 Connection Details

The rear panel connector layouts for the four cabinet types are shown in Figures 3-1 to 3-4.

3.3.1 Mains Input

This is a fixed socket with moulded free lead conforming to IEE regulations.

Europe:

Brown connects to Live
Blue connects to Neutral
Green/Yellow connects to Earth.

North America:

Black connects to Live
White connects to Neutral
Green connects to Earth.

Note: Set voltage selector to position for local supply with fuse value as follows:

220-260 VAC - 0.5 amp SLO BLO
100-130 VAC - 1 amp SLO BLO

3.3.2 Signal Input

The 7 pin connections for the input signals to the conditioning modules must be correctly wired. Signal input pin connections are;

Pin	Connection
1	Transducer Supply +ve
2	Transducer Supply -ve
3	Not connected
4	Input LO
5	Input HI
6	Auxiliary Supply/Input
7	Frame

Note: The above connections only apply if there is a signal conditioner fitted to that particular channel.

3.3.3 Output Conditioning

The M1000-12/P, -16/P and -24/P cabinets have an output conditioning section (accessed by a hinged cover on top of the cabinet), which accepts various post-conditioning cards, e.g. active filters, integrators, power amplifiers, etc. If this section is not used, it is necessary to fit Channel Completion cards type M1088-P to route the voltage and current outputs through to the rear panel D connectors.

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3.3.4 Output Connections

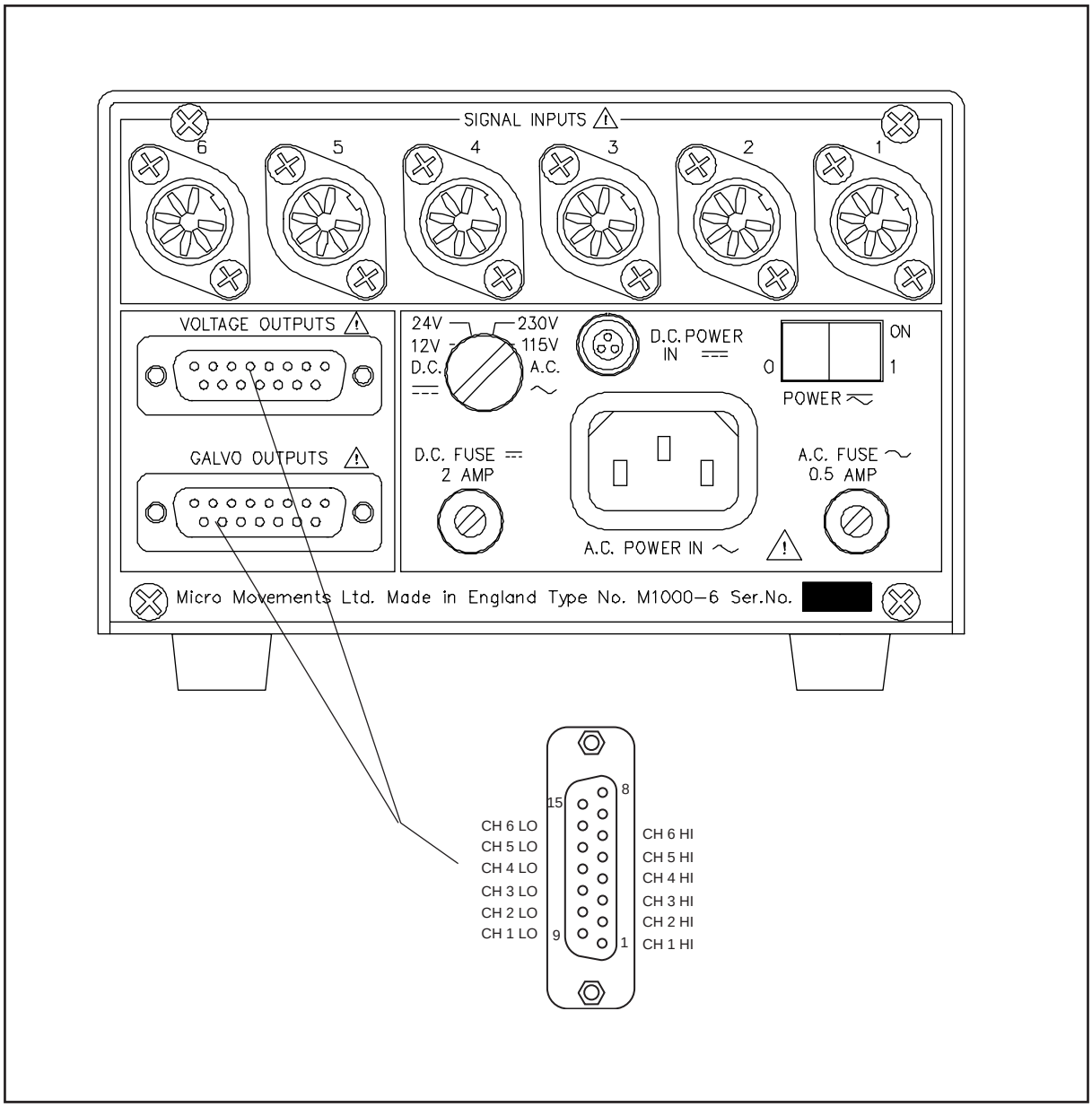

Figure 3-1 M1000-6 Voltage and Galvo Output Connectors

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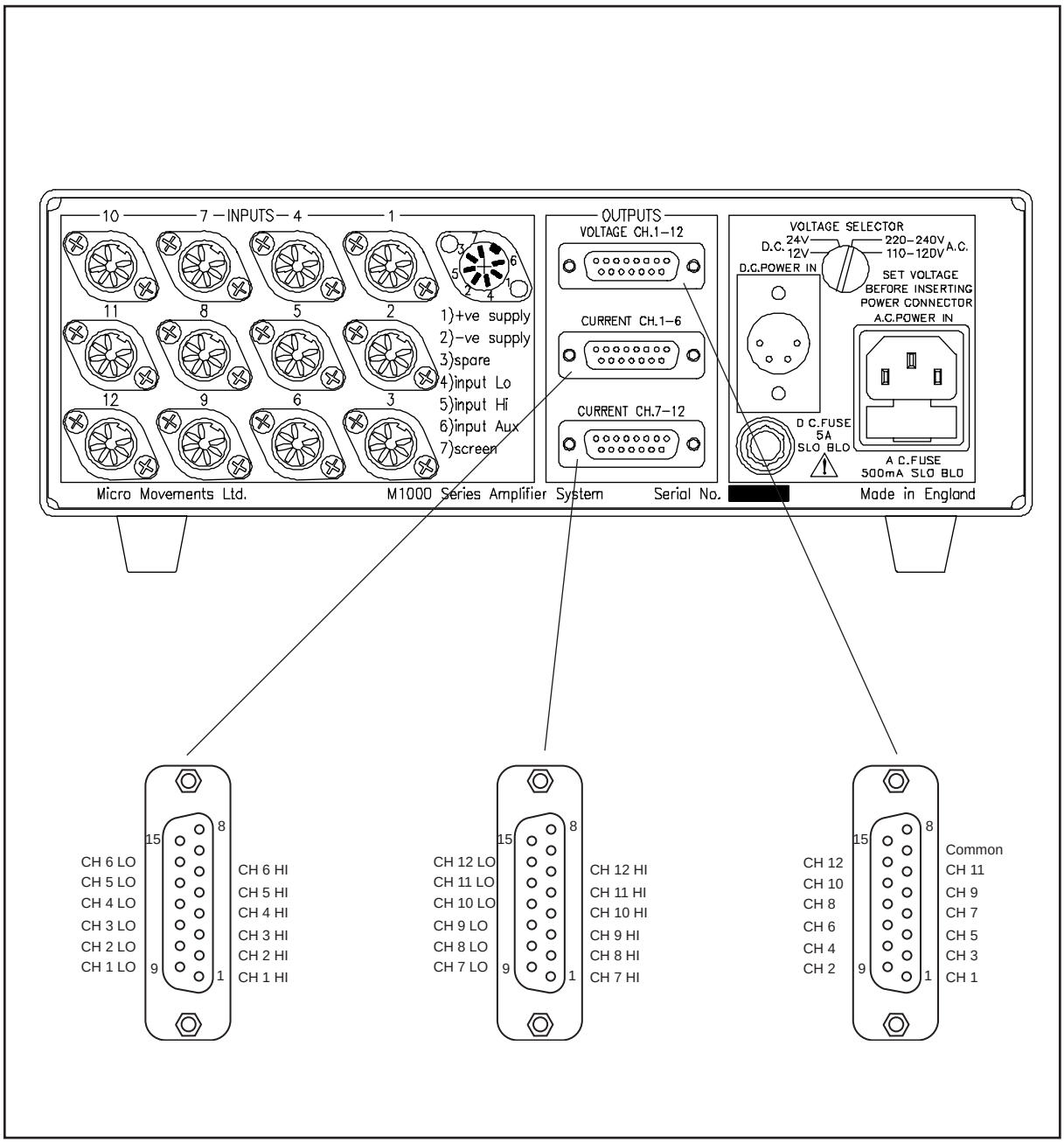

Figure 3-2 M1000-12 Voltage and Current Output Connectors

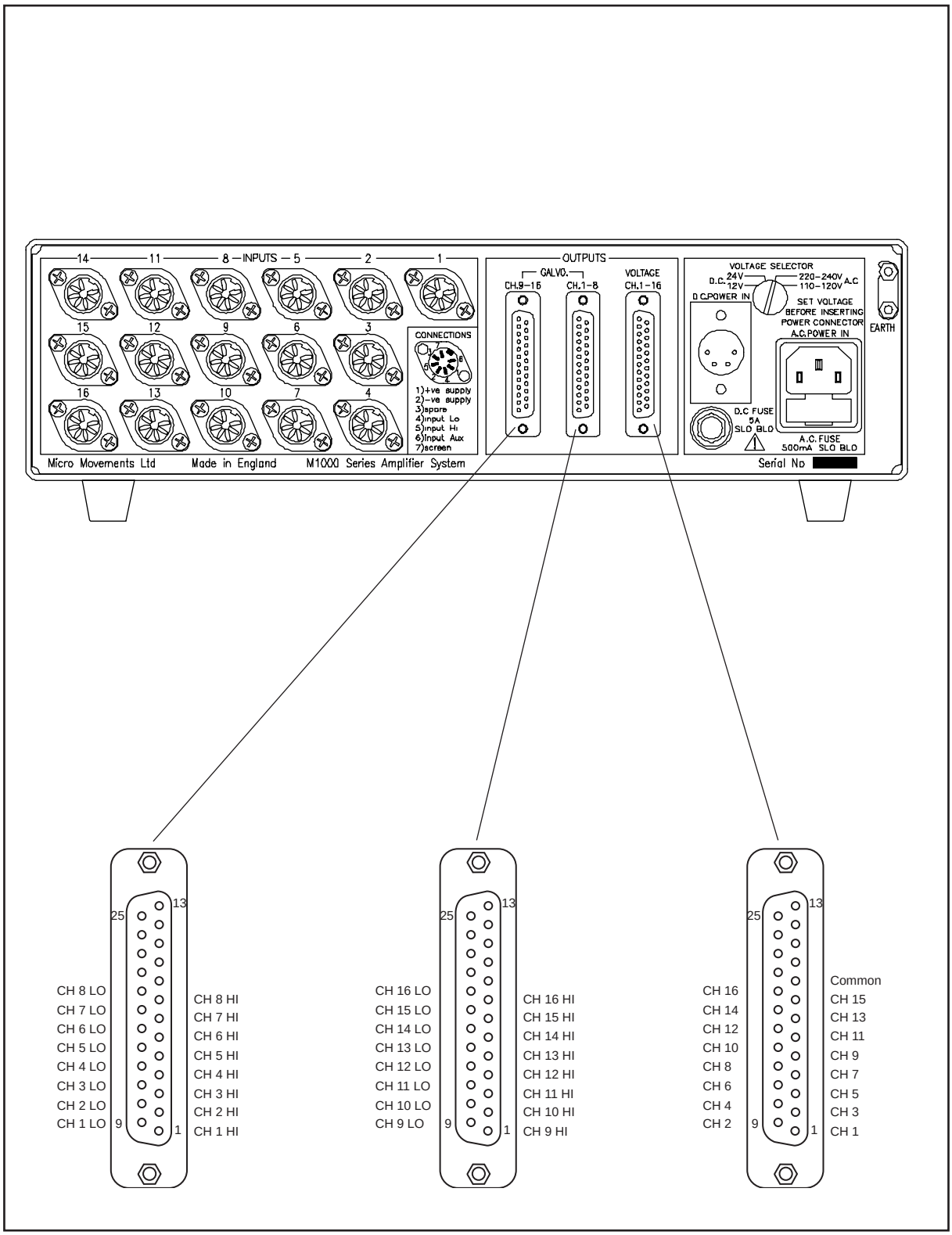

Figure 3-3 M1000-16 Voltage and Current Output Connectors

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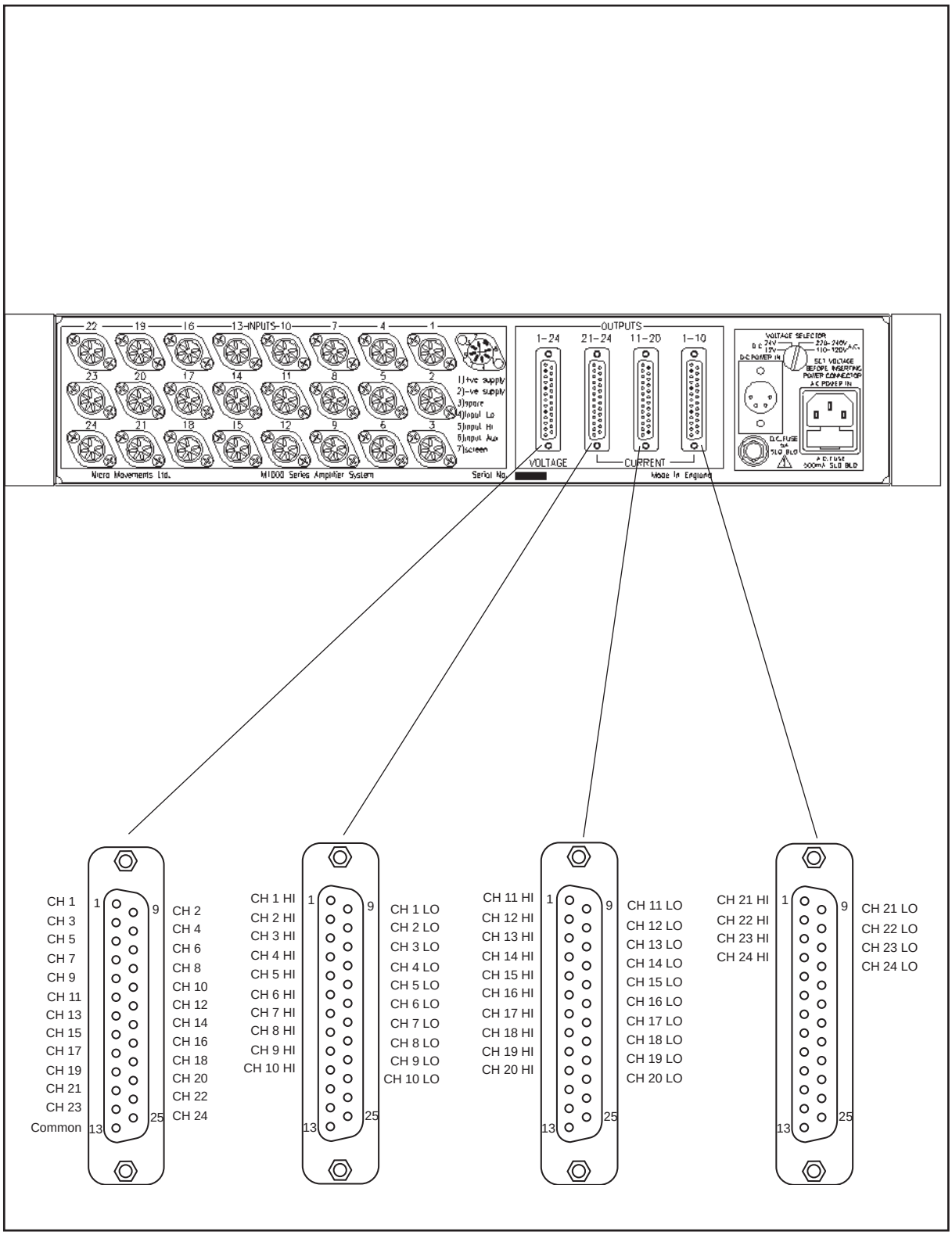

Figure 3-4 M1000-24 Voltage and Current Output Connectors

3.3.5 A6 Inverter

The A6 Inverter is a factory installed option, which is available on all models, allowing DC operation of the systems. The connections and precautions listed below should be followed:

i) Ensure that the mains lead is disconnected and set the Voltage Selector to the correct position.

ii) Connect the DC supply (Battery) to the cabinet using the cable supplied.

Cable Specifications

Nominal Area	Maximum Length
6 sq. mm	2M each lead
10 sq. mm	5M each lead
16 sq. mm	10M each lead
35 sq. mm	25M each lead

Supply Voltage Range

Nominal 12VDC:	11 - 14V
Nominal 24VDC:	22 - 29V

Nominal Current

	M1000-6	M1000-12	M1000-16	M1000-24
12V	1 amp	1 amp	2 amps	2.5 amps
24V	0.5 amp	0.5 amp	1 amp	1.5 amps

3.4 Rack Mounting Kit (M1000-24 only)

The M1000-24 may be factory fitted with Rack Mounting Brackets, compatible with standard 19" rack frames. If the rack depth is advised, telescopic slides can be provided which fit directly onto the sides of the cabinet. The Rack Mounting option may be retrofitted.

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SECTION 4 - OPERATION

The M1000 Series of instruments are configured to accept a range of plug-in signal conditioning modules and data amplifiers and can thus be used as completely self-contained data acquisition systems with a very wide range of transducers, such as load cells, thermocouples, strain gauges, pressure transducers, accelerometers, flowmeters, displacement transducers etc..

The controls described in this section are adjusted in conjunction with the conditioning module controls to set the system for use. Their operation in most cases is self evident, however some details need explanation. For further details of the conditioning controls, calibration and set up refer to the individual conditioning module User Guides.

4.1 Front Panel Controls

Figure 4-1 shows the front views of the M1000-6 and -12. The front panel controls of the M1000-16 and -24 are similar to those of the M1000-12, only the number of usable channels differ.

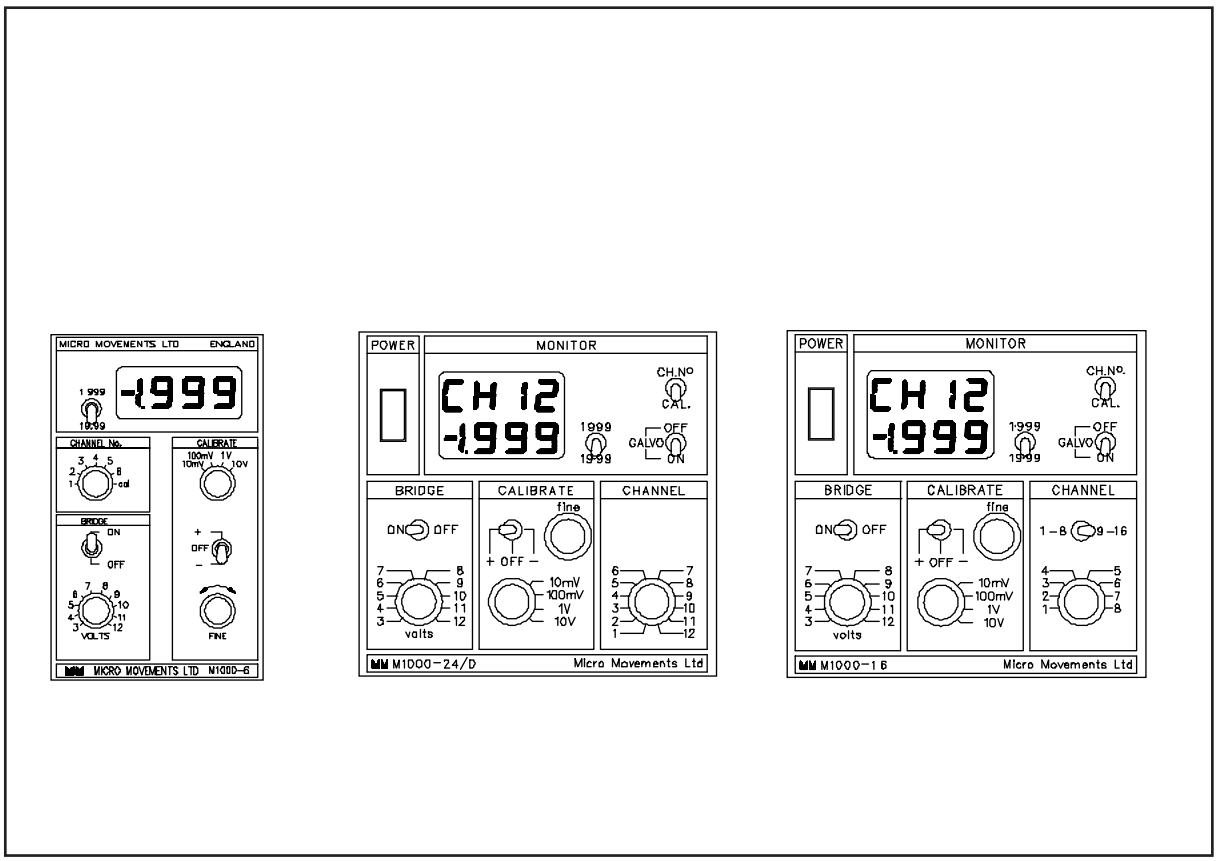

Figure 4-1 Front panel of M1000-6 , M1000-12 and M1000-16

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Monitor

The monitor on the -12, -16 and -24 displays two lines of data, the -6 displays one line:

- Channel number being displayed or calibration e.g. CH11 or CAL. (Not for M1000-6)

- A 3 1/2 digit voltmeter with auto polarity which is used to monitor either the voltage output from any signal conditioning module or the output from the calibrator.

There are also three switches associated with the monitor:

1.999/19.99

This is the Voltmeter Range Selector switch. The maximum value that can be displayed is represented by the two switch positions, 1.999 and 19.99.

CH. No./CAL

The CH.No./CAL toggle switch (not M1000-6) is used to select the monitor input, either a channel input or the calibration section output.

Galvo. OFF/ON

The Galvo. ON/OFF toggle switch (not M1000-6) controls the power supply to the signal conditioning modules. With this switch on the Galvo. OFF position the galvanometers can be rotated to a suitable mechanical zero, (refer to the Calibration Section at the end of each module User Guide).

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Channel No. (M1000-6)

This rotary switch selects the channel ouput (1 to 6) for display on the monitor. The internal DC calibration voltage can also be selected for display.

Channel (M1000-12, -16, -24)

Two switches are used for channel selection:

a) A rotary switch to select channels 1 to 12

b) A toggle switch to select 1 to 12 or 13 to 24

In the 13 to 24 position 12 must be added to the value indicated on the rotary switch. The channel selected is displayed on the monitor.

Bridge

The two switches in the BRIDGE box control the output of the Transducer Power Supply.

The rotary switch selects the voltage of the power supply between 3 and 12 volts in 1V increments and the toggle switch is an ON/OFF control.

Calibrate

In the CALIBRATE box there are two switches and a potentiometer to control the M1016 calibrator. The range switch is a four position rotary switch with the ranges 10mV, 100mV, 1V and 10 volts. The three position toggle switch gives three values of calibration:

Positive, OFF and Negative.

The fine gain potentiometer allows adjustment of the calibration voltage to any value. The calibration can be set utilising the monitor in the CAL position. To set a small voltage accurately adjust the value on a higher range of the rotary switch and then turn to the lower range.

e.g. If a value of 4.32 volts is set on the 10V range and the rotary switch is turned to the 10mV range, a voltage of 4.32mV will appear at the input to the amplifiers. More details can be obtained from the calibration section contained within the indiviual module User Guides.

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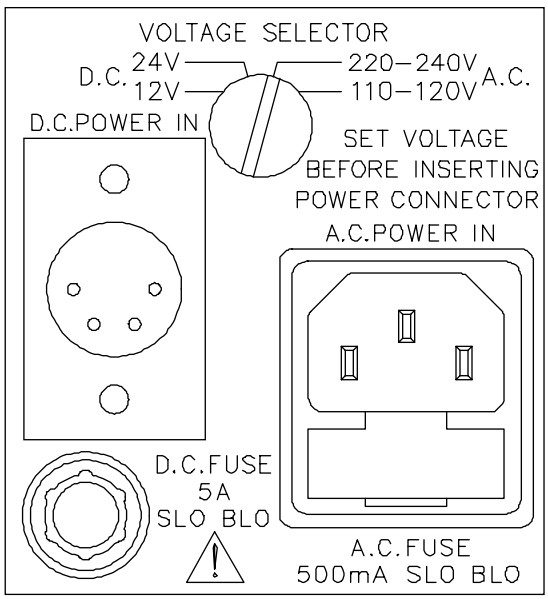
4.2 Rear Panel Controls

- Input Connectors - 7 pin DIN. (See section 2 for connection details).
- Voltage Outputs - Female D connector contains voltage output suitable for tape or logger from each of the signal conditioning channels.
- Galvanometer Outputs - Female D connector contains output for connections to a Micro Movements galvanometer from each of the signal conditioning channels.
- Voltage Selector - Rotary switch for selection of required supply voltage, 12VDC, 24VDC, 115VAC or 230VAC.
- DC Fuse - 2 amp (M100-6) 5 amp (M1000-12, -16, -24), 5 x 20mm fuselink.
- DC Power In - 2 pin connector (M1000-6), 4 pin XLR connector (M1000-12, -16, -24).
- AC Power In - standard IEC socket.
- Power - On/Off switch for instrument (M1000-6 only), applicable to DC or AC supply.
- AC Fuse - 0.5 amp, 5 x 20mm fuselink.



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C103/C104 HIGH VOLTAGE CONNECTORS

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C103/C104 HIGH VOLTAGE CONNECTORS

1 Description

The C103 and C104 are High Voltage input connectors for use with signal conditioning amplifier modules. The C103 connector includes a 60dB balanced attenuator with an input impedance of 10 Megohms to earth on each input (20 megohms balanced). The C104 connector includes an 80dB balanced attenuator with an input impedance of 100 Megohms to earth on each input (200 megohms balanced). Both include a mating socket for connection to the high voltage source. They can be used with the Mxx60 and Mxx70 amplifiers to extend their range to read voltages up to 250 volts A.C. and also with the Mxx80 to measure the frequency of high A.C. voltages, e.g. 230V/115V power lines.

1.1 Attenuation

C103 Fixed 60dB (1,000:1)

C104 Fixed 80dB (10,000:1)

1.2 Installation

Incoming High Voltage lead:

1 Lo
} Signal Input
2 Hi

3 Earth

WARNING

THIS CONNECTOR MUST BE EARTHED TO PIN 3 OF INPUT CONNECTOR AND CONNECTOR SHELL.

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2 Calibration

When used with Mxx60 and Mxx70 modules, the calibration procedures are followed as per the individual modules and the voltage referred to the input is multiplied by either 1,000 (C103) or 10,000 (C104).

Example

An input voltage of 200V is required to deflect 2 cm on the recorder.

The Mxx60 or Mxx70 are calibrated using a calibration voltage of 200 divided by 10,000 = 20 mV.

The Mxx80 calibration is not affected by the use of the C104. It should be noted however, that the Mxx80 has a minimum sensitivity of 10 millivolts RMS. When the Mxx80 is used with the C104 the minimum sensitivity of the Mxx80 is therefore increased to 100V RMS.

3 Typical Input Circuit

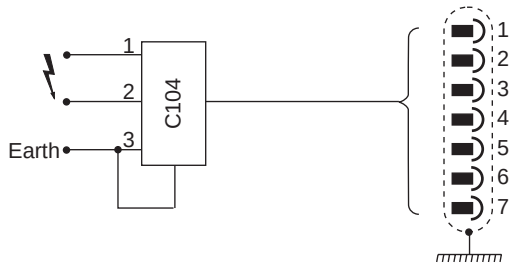

Figure 1 High Voltage

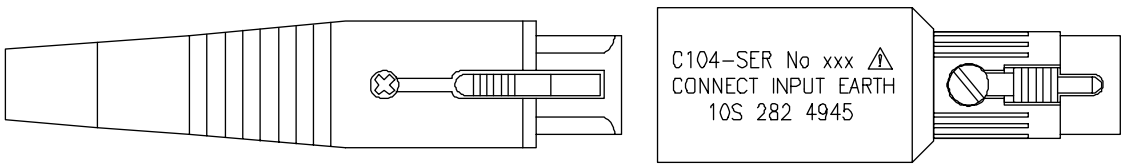

Figure 2 C103/C104 Side View

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C103/C104 HIGH VOLTAGE CONNECTORS

1 Description

The CN/A series are current shunt connectors for use with signal conditioning amplifier modules. The CN/A contains a very low resistance, non-inductively wound copper wire with voltage take-off points fed to the 7-pin DIN connector. The value of the shunt resistance provides for an insertion voltage drop of 50mV at maxiomum rated current. There are three model allowing for maximum currents of 10Amp, 5Amp and 1Amp. They can be used with the Mxx60 and Mxx70 amplifiers and are suitable for AC and DC current measurements.

1.1 Shunt Values

C10/A	10 amps (50mV drop at 10 amps)
C5/A	5 amps (50mV drop at 5 amps)
C1/A	1 amp (50mV drop at 1 amp)

1.2 Installation

Incoming lead:

1 Not connected

2 Earth

3 Input High

4 Input Low

WARNING

THIS CONNECTOR MUST BE EARTHED TO PIN 2 OF INPUT CONNECTOR AND CONNECTOR SHELL.

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M1043 SYNCHRO/D.C. CONVERTER

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M1043 SYNCHRO/D.C. CONVERTER

1 Description

The M1043 Synchro/DC Converter produces a DC output signal proportional to the angular position of a synchro or resolver. The input range is from 11.8 to 90VAC. Applications include radar antenna position information, C.N.C. machine tool positional control, motor control, robot axis control, gyros and general aircraft and marine use. The module comprises a high precision integrated converter and DAC. The gain and sector controls allow maximisation of angular resolution.

2 Front Panel Controls

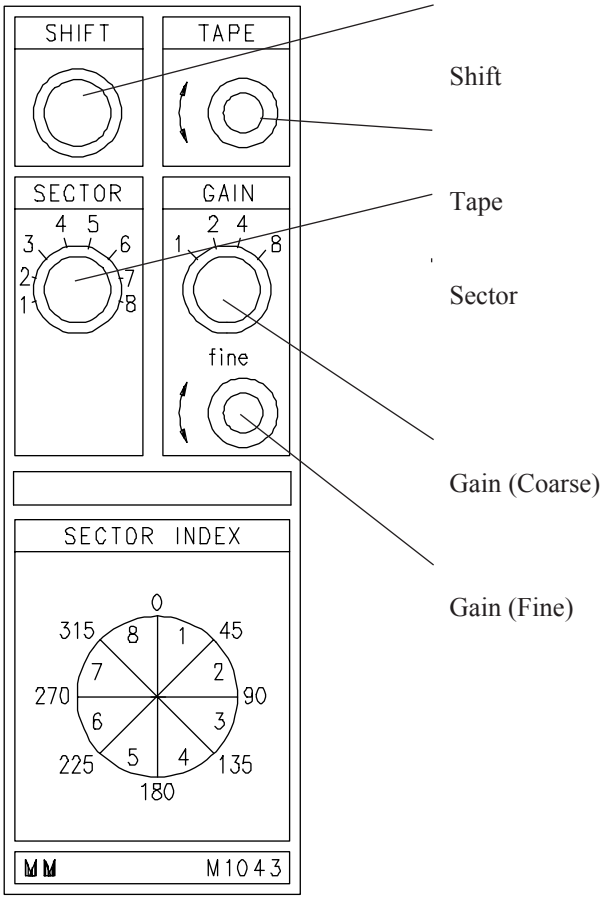

Figure 1 M1043 Front Panel

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2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or output offset control on the current output, enabling the galvanometer to be shifted over plus or minus full scale output.

2.2 Tape

A 15-turn potentiometer is used to adjust the voltage output of the amplifier independent of the galvanometer output. The tape voltage output can be used to drive recorders, oscilloscopes, digital voltmeters or other voltage driven devices. The output voltage is adjustable up to 2V DC.

2.3 Sector

An 8 position rotary switch is used to select one of eight sectors, 0 - 360° in 45° steps. The sector control injects a fixed offset and places the zero at the beginning of the selected sector (as shown in the diagram at the bottom of the front panel). The shift control provides fine trimming of the zero position.

Using these controls allows, at one extreme, one complete revolution (360°) to be set for full scale output, or, at the other extreme, 315° to 360° to be set for full scale output.

2.4 Gain

The range over which the unit will operate is determined by two controls, coarse and fine.

Coarse

The coarse control is a rotary switch giving the following gain values:

x1
x2
x4
x8

Fine

The fine control is a 15-turn potentiometer which interpolates the switched steps.

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3 Specification

Input Configuration:	S1, S2, S3, R1, R2 Synchro S1, S2, S3, S4, R1, R2 Resolver
Input Impedance:	160 Kohms differential
Input Range:	11.8V line to line (S1 - S4) 4V to 50V r.m.s. (R1 - R2)
Input Frequency:	50Hz to 400Hz
Resolution:	12 bit (5.3 minutes)
Accuracy:	±10 minutes
Repeatability:	5.3 minutes
Bandwidth:	500 Hz
Tracking Rate:	200 RPS
Settling Time:	15 mS
Noise:	Less than 0.1% (r.t.o.)
Sector:	8 ranges, 0 - 360° in 45° sectors
Gain:	4 ranges, x1, x2, x4, x8 with interpolate control.
Shift:	0 - 45°
Output Voltage:	Up to ±10V DC
Output Impedance (Voltage):	0.5 ohms
Output Current:	±10mA into 120 ohms
Output Impedance (Current):	250 ohms
Package:	Double width M1000 series module.

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4 Typical Input Circuits

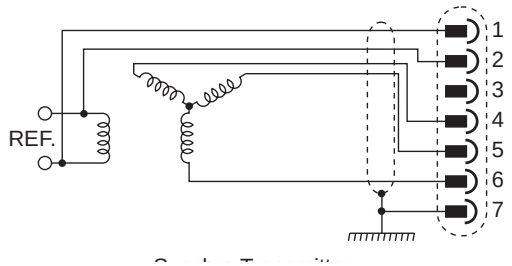

Figure 2 Synchro Transmitter

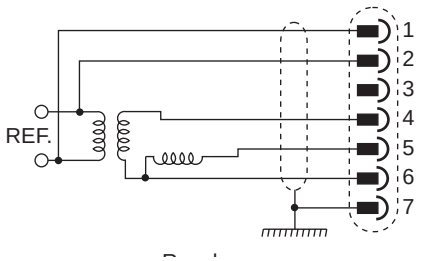

Figure 3 Resolver

IMPORTANT

The typical inputs shown are for direct input. Many applications require isolation in the form of transformer coupling for resolvers or Scott connected transformers for Synchro input. Any isolating transformer configuration will be external to the instrument. These can be supplied by Micro Movements. Details are available on request.

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M1049 CARRIER MODULE

1 Description

The M1049 is a self-contained carrier oscillator, amplifier, demodulator and filter which is primarily intended for operation with inductive transducers in half or full bridge configuration, e.g. variable reluctance transducers, differential transformers (LVDTs) etc.

Features include low noise and high bandwidth for this type of system, full input protection up to ±30V, wide dynamic range and galvanometer protection by output current limiting.

2 Front Panel Controls

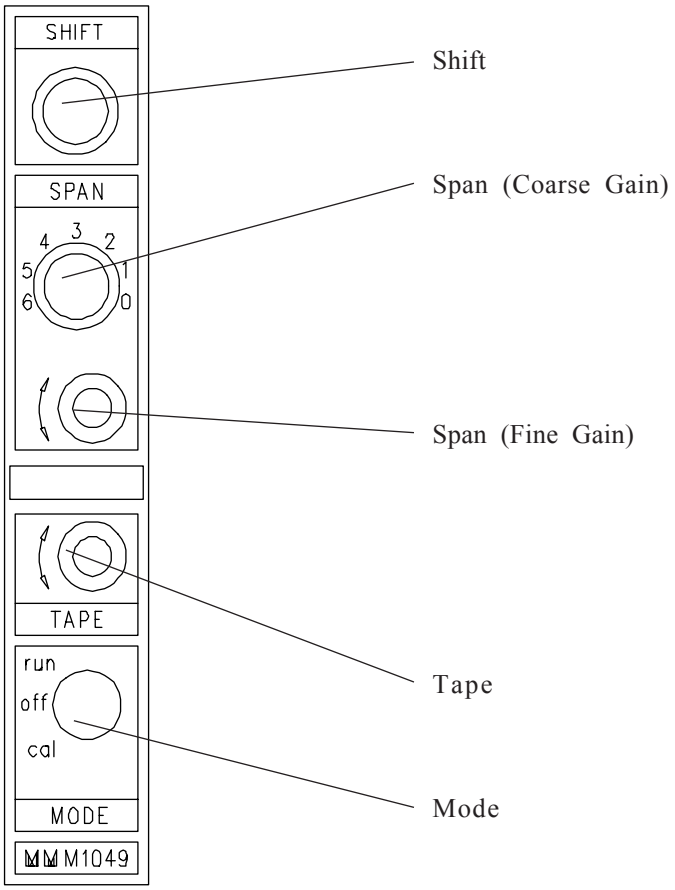

Figure 1 M1049 Front Panel

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3 Internal controls

3.1 Calibration Level

There are three calibration voltages which can be set by the DIP switches on the side of the module.

Switch 3

Range	Pole 1	Pole 2	Pole 3	Calibration	Typical Applications
LOW	ON	OFF	OFF	5mV RMS	Resistance Bridge
MEDIUM	OFF	ON	OFF	20mV RMS	Inductive Pressure
HIGH	OFF	OFF	ON	100mV RMS	LVDTs

The amplifier has a separate buffered voltage output which appears on a socket at the rear of the recorder/signal conditioning cabinet. The nominal output level with a 10cm deflection on the galvanometer can be adjusted by means of the potentiometer marked Tape between 1V and 2V approximately.

3.2 Zero Balance Range

There are three Zero Balance ranges which can be preset by the DIP switches on the side of the module.

Switch 3

Range	Pole 4	Pole 5	Typical Applications
Fine	ON	OFF	Bridges with a close balance (within ±0.2%)
Medium	OFF	ON	Inductive Pressure Transducers with balance ±2%
Coarse	OFF	OFF	LVDTs with balance ±10%

4 Bridge Completion

The M1049 will operate directly with transducers in the half or full bridge mode (see section 6).

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6 Typical Input Circuits

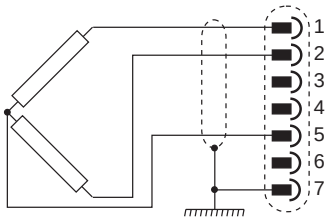

Figure 2 Variable Reluctance

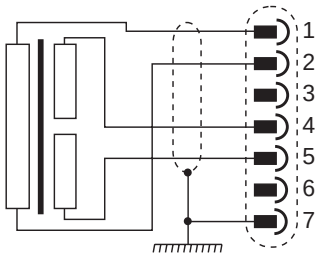

Figure 3 Differential Transformer

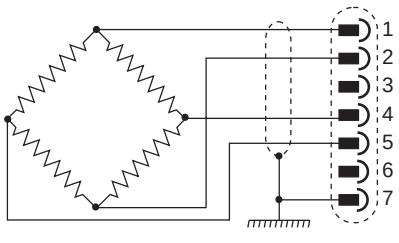

Figure 4 Piezoresistive Transducer

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Note:

- On the M12-150A the Galvo. ON/OFF switch is fitted inside the Signal Conditioning access hatch on the top of the instrument.
- This feature is not fitted to M1000-6.

7.1 Calibration Procedure

1) Recorders Only

   Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

Note: If all channels are not in use it is preferable to use the centre channels for the best optical fidelity, e.g. Channels 3 through to 7.

2) Galvo. ON/OFF switch to ON.

   This switch provides power to the amplifiers. Rotate the shift control to set the monitor voltage to 0.00V. Observe the galvo. spot on the viewing scale; it should be on the position as set in 1). i.e. 11. If it is not, check the procedures again. Otherwise there is a fault in the amplifier.

3) RUN/OFF/CAL switch to CAL.

   Use the fine gain potentiometer to set the spot to give a deflection of 5.56cm on the viewing scale, i.e. 11 - 5.56 = 5.44.

4) Use the TAPE potentiometer to set the Monitor display to 1.112 volts

5) RUN/OFF/CAL switch to RUN.

   Position the LVDT armature to a known position, e.g. centre point. Use the zero balance to adjust the monitor to the corresponding value, e.g. the centre point would be 1.00 volts.

The system is now fully calibrated and ready for use.

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M1060 HIGH GAIN AMPLIFIER

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M1060 HIGH GAIN AMPLIFIER

1 Description

M1060 is a high gain differential-input DC amplifier primarily intended for operation with strain gauges in 1, 2 or 4 external arm mode, load cells, pressure transducers and similar low-level sensors.

Features include high input impedance, low noise and drift, full input protection up to 30V differential, wide dynamic range and galvanometer protection by output current-limiting.

2 Front Panel Controls

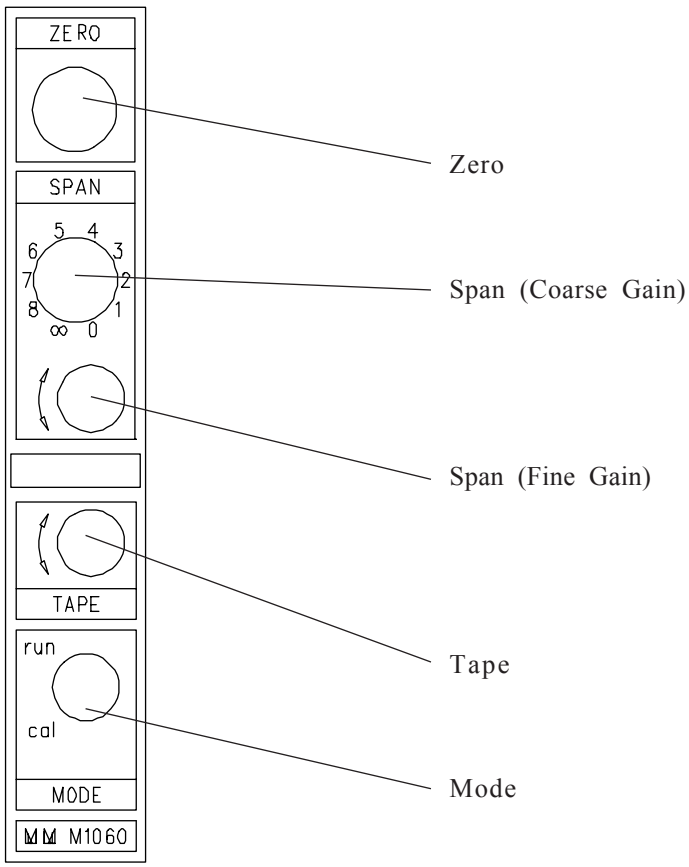

Figure 1 M1060 Front Panel

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2.1 Zero

This is a 22-turn potentiometer which functions as a bridge balance or input offset control. Its range is approximately ±20mV at the input terminals (±4000 microstrain at 10V bridge excitation). However, the range can be modified by internal adjustment, (see section 4.2).

2.2 Span

The amplifier span (gain) is set by two controls, coarse and fine, which cover the approximate range 20 to 5000:1.

Coarse Gain

The Coarse Gain control is a 10-position rotary switch calibrated such that in each successive position the gain is halved. The gain settings are as follows:

Position	Gain (approx.)	Typical input for a 5cm deflection	
		Min. (V)	Max. (V).
0	5000	0.4	0.7
1	2500	0.7	1.5
2	1250	1.5	3
3	625	3	6
4	312	6	11
5	156	11	22
6	78	22	45
7	39	45	90
8	20	90	175
00	0.5	N/A	N/A

Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range.

2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ±2V DC.

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2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

3 Internal controls

3.1 Bridge Completion

The amplifier may be used with resistive bridge networks in the 1, 2 or 4 arm mode. In the 1 or 2 arm mode bridge completion is achieved by connecting dummy bridge arms within the amplifier by means of an internal switch (SW2).

The switch is a 6-pole 2-position type, of which poles 1, 2 and 3 are concerned with bridge conditioning. The dummy bridge arms should be switched in according to the input configuration, as follows:

Full Bridge: In this case the bridge is completed within the transducer, therefore poles 1, 2 and 3 should be in the Open position.

Half Bridge: Poles 1 and 2 are Closed, bringing in the two 499 ohm dummy arms (R25 and R26). Pole 3 remains Open.

Quarter Bridge: Poles 1, 2 and 3 are Closed. Note that closing Pole 3 brings in R27, which is normally 120 ohms. If the resistance of the single external bridge arm is different from this value R27 must be changed to match it. (See also Typical Input Circuits).

3.2 Low Noise Operation

To minimise output noise at high gains a low pass filter can be switched in by closing Poles 4 and 5 of SW2. This, however, has the effect of reducing the bandwidth to approximately 150Hz.

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4 Sensor Excitation

4.1 Transducer Supply

The 3 - 12V DC transducer supply (M1015) appears on pins 1 and 2 of the amplifier. These are connected (via R1 and R2) to pins 3 and 4, which in turn are connected to pins 1 and 2 on the 7-pin Signal Input Connector at the rear of the instrument. Thus the transducer cannot be energised unless there is an amplifier present in that particular channel. Note that the amplifier is normally supplied with R1 and R2 replaced by wire links so that the full supply (3 - 12V DC as selected by the Bridge Volts switch) appears across the transducer. However, if a reduced supply is required on a particular channel these may be replaced by resistors of the appropriate value to act as droppers in the supply lines.

For example: With 10V excitation selected, a particular strain gauge is required to be energised with 2.5V.

Bridge resistance = 120 ohms

Bridge excitation = 2.5V

Volt drop required = 7.5V

Therefore:

R1 + R2 = (120x7.5)/2.5 = 360 ohms

So R1 and R2 are 180 ohms each.

Provision is also made to reverse the excitation polarity by means of links, (A or B), on the board, or of course this may also be achieved by reversing pins 1 and 2 on the Signal Input connector.

4.2 Zero Balance Range

Bridge balance is set by a 22-turn potentiometer which has a nominal range of ±20mV at the input (±4000 microstrain for 10V bridge excitation). For transducers with a very large residual imbalance the range of this control may be increased by the adjustment of R10.

5 Voltage Output Range

The amplifier has a separate buffered voltage output which appears on the Voltage Output socket on the rear of the instrument. The nominal output level with a 10cm deflection on the galvanometer can be adjusted by means of the potentiometer marked Tape up to ±2V DC.

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6 Specification

Input Configuration:	High Gain Differential
Input Impedance:	1 Megohm Differential
Input Mode:	1) Resistive bridge in 1, 2 or 4 arm connection with internal bridge completion. 2) Low level signals generally.
Input Range:	Up to 500 mV (approx.)
Maximum Input:	30V D.C.
Common Mode Rejection:	90dB (D.C. to 60 Hz)
Noise:	Less than 5 microvolts r.m.s.(r.t.i.) at max. gain.
Drift:	Less than 2 microvolts/°C (r.t.i.) at max. gain.
Bandwidth:	D.C. - 5KHz.
Gain:	20 - 5,000 in switched steps with interpolate control.
Output (Voltage):	Up to ±10V DC
Output impedance (Voltage):	0.5 ohms
Output (Current)	±10mA into 120 ohms
Output Impedance (Current):	250 ohms
Package:	Standard M1000 series module

7 Typical Input Circuits

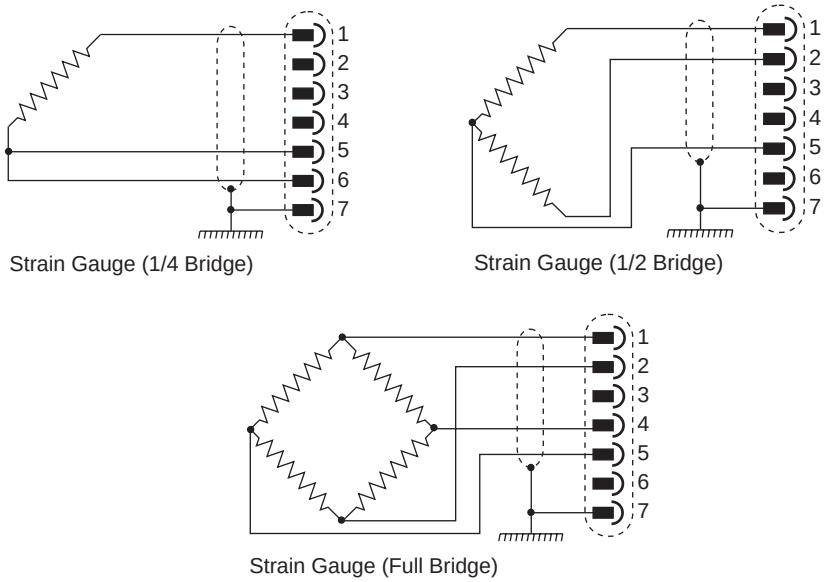

Figure 2 Strain Gauge

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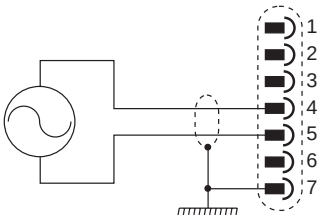

Figure 3 Analogue Signals

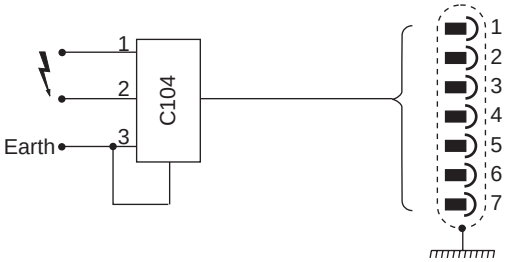

Figure 4 High Voltage

8 Calibration

A true calibration of any system can only be achieved by applying a known physical stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc. The M1016 calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1060 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal

switch on the recorder to Ch. No. The meter should now read 0.00V. Adjust using the Zero potentiometer.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control, as in b) above.

There are two further considerations regarding the zero condition:

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in b) above, the calibration is normally unaffected.

e) When the amplifier is switched from Run to Cal mode there may be a zero shift due to a change in the input conditions. This can be nulled as before without any effect on the calibration.

Mode Switch (Amplifier)

This is usually a 2-pole changeover switch connected to the amplifier input terminals.

- In the Operation (RUN) position the amplifier input is connected directly to the signal source (usually a transducer) via pins 4 and 5 on the Signal Input connector at the rear of the instrument.
- In the Calibration (CAL) position the input is connected to a calibration voltage derived from the recorder or signal conditioning cabinet.
- There are some versions of the M1060 module which are fitted with other types of calibration facility (e.g. Shunt cal.). If in doubt consult the Company.

8.1 Calibration Procedure

A typical calibration procedure for one channel would be as follows:

Take a pressure transducer with a nominal output of 40mV for full scale pressure with 10V excitation (typical for an unbonded strain gauge type). However, it is unlikely that any particular transducer would have an output of exactly 40mV, more likely it would be somewhere within ±10% of this value. So, we look at the manufacturers calibration certificate supplied with the transducer and see that this is a 75 PSI unit which has an output of +38.68mV at 75 PSI if energised with a 10V DC supply.

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Note: If energised by a different supply the output is normally pro-rata but the temperature coefficient is sometimes degraded.

The transducer has a zero imbalance (i.e. an output when no pressure is applied) of -2.97mV. Therefore the total output change for 75 PSI applied is the sum of these two (because the zero imbalance happens to be negative):

38.68 + 2.97 = 41.65mV.

It would be sensible if we made 75 PSI equivalent to 7.5cm excursion on the chart so that in analysis the pressure is read direct from the grid lines (1cm = 10PSI). Thus the calibration figure would be:

41.65 x (10/7.5) = 55.5mV for 10cm deflection.

Preset the controls as follows:

M1060 Front Panel Controls

Zero Balance Potentiometer	*
Range Switch :	6
Fine Gain	Fully Counter-clockwise
Tape Control	Fully Counter-clockwise
Run/Cal Switch	Cal

DIP Switch

1	Half Bridge	OFF
2	Half Bridge	OFF
3	Quarter Bridge	OFF
4	Low Pass Filter	OFF
5	Low Pass Filter	OFF
6	Not Used	OFF

Monitor Unit Controls

Monitor Range Switch	19.99
Monitor Ch. No./Cal Switch	Cal
Galvo. On/Off	OFF
Channel	N
Bridge Voltage (as required for transducer)	10V
Bridge On/Off	OFF
Calibrate +/OFF/-	+
Calibrate Fine	*
Calibrate Range	10V

* Not Important

N Corresponding to channel being calibrated

Note: On the M12-150A the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

1) Using the Calibrate FINE potentiometer set the voltage on the Monitor to 5.55V.

2) Turn Calibrate RANGE to 100mV. There will now be 55.5mV on the mainframe calibration bus.

3) Recorders only. Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

Note: If all channels are not in use, it is preferable to use the centre channels for the best optical fidelity.

4) Galvo. ON/OFF switch to ON. (This switch provides power to the amplifiers.)
Calibrate +/OFF/- switch to OFF
Monitor CH. No./CAL switch to CH. No.

5) Adjust the ZERO balance potentiometer on the amplifier to give 0.00V on the monitor. Observe the galvo. spot, it should correspond to the position set in 3) i.e. 11. If there is a discrepancy, recheck, as either the amplifier is faulty or there has been a wrong setting.

6) Calibrate +/OFF/- switch to +.

Adjust the spot deflection to 10cm. i.e. position 1 on the viewing scale using the FINE gain control on the amplifier. If 10cm cannot be achieved turn the RANGE switch one position clockwise to increase the gain by 2, then reduce the FINE gain to re-adjust to 10cm.

7) Using the TAPE potentiometer on the amplifier, set the monitor voltage to a suitable value, e.g. 2.00V. At this stage the system has been calibrated for a sensitivity of 1cm/10 PSI on the recorder and a voltage output of 200mV per 10 PSI.

8) Calibrate +/OFF/- switch to OFF.

If there has been a change from the original settings of 11 on the graticule or 0.00V on the monitor repeat the above procedure from the original preset values in order to fine tune the system.

9) RUN/CAL switch on the amplifier to RUN.

Use the ZERO balance potentiometer to set 0.000V on the monitor. The galvanometer spot should still correspond to position 11 on the viewing scale.

10) Bridge ON/OFF switch to ON

The zero will almost certainly move due to residual offset. Use the Zero control to position the spot to the original zero position, i.e. 11 on the graticule.

11) The system is now fully calibrated and ready for use. If a different position is

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preferred for the galvo. mechanical zero, set the Galvo. ON/OFF switch to the OFF position before moving the galvo. Return the switch to ON after the galvo. has been set.

12) If, after step 10), the galvo. or voltmeter are completely off scale note the position of the range switch and temporarily reduce the gain of the amplifier by turning the range switch counter-clockwise one or two positions to find the spot and then re-balance. If it still cannot be re-balanced there must be a fault in the bridge circuit, all four arms of the bridge should be checked at the free connector.

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M1061 THERMOCOUPLE AMPLIFIER

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M1061 THERMOCOUPLE AMPLIFIER

1 Description

M1061 is a high gain amplifier for use with thermocouples and similar low-level sources. (A special input connector, type C1061/R, with a built-in cold junction reference, is available for use with this module.)

Features include high input impedance, low noise and drift and input protection up to ±12V across the input terminals.

2 Front Panel Controls

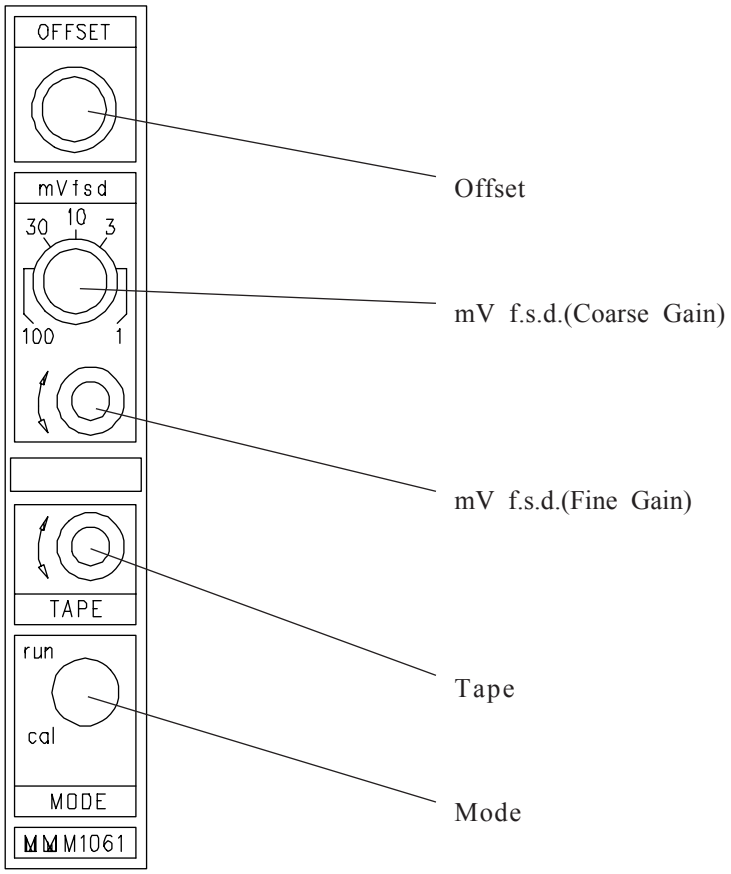

Figure 1 M1061 Front Panel

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2.1 Offset

A 22-turn potentiometer which acts as a back-off or input offset control enabling the output to be shifted over plus and minus full scale range.

2.2 mV f.s.d.

The amplifier gain is set by two controls, coarse and fine.

Coarse Gain

The Coarse Gain control is a rotary switch calibrated in input millivolts for full-scale output in the following steps:

100mV
30mV
10mV
3mV
1mV

Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range.

2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ±2V DC.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

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3 Internal controls

3.1 Compensation Range

Because different types of thermocouple exhibit different sensitivities it is necessary to change the range of the compensation network which is used with the input connector/reference junction. This is achieved by operation of poles 1 - 3 on the internal 6-pole switch (SW3). For application information, refer to C1061/R. When this connector is not used, poles 1, 2 and 3 of SW2 should be left open.

Poles 1, 2 and 3 of SW3 are used as follows:

Pole 1 Closed: Gives cold junction compensation at a rate of 41µV/°C RTI (Type K thermocouple - Chromel/Alumel).

Positive: Nickel/chromium

Negative: Nickel/aluminium

Pole 2 Closed: Gives cold junction compensation at a rate of 53µV/°C RTI (Type J thermocouple - Iron/Constantan)

Positive: Iron

Negative: Constantan

Pole 3 Closed: Enables other sensitivities of thermocouple to be compensated. A resistor may be fitted by the user to provide the desired compensation rate.

The value of this resistor may be determined from the formula below:

R37 = ((1224/Vth)-12) kohms

where Vth is the thermocouple sensitivity in µV/°C.

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4 Specification

Input Configuration:	High Gain Differential
Input Impedance:	200 Kohm Differential
Input Mode:	1) Any type of thermocouple with or without C1061/R electronic reference module 2) Low level, low frequency signals generally.
Input Range:	Up to 100 mV
Maximum Input:	±12V D.C.
Common Mode Rejection:	90dB (D.C. to 60 Hz)
Noise:	Less than 5 microvolts r.m.s.(r.t.i.) at max. gain.
Drift:	Less than 2 microvolts/°C (r.t.i.) at max. gain.
Bandwidth:	D.C. - 1KHz.
Gain:	25 - 10,000 in 5 switched steps with interpolate control.
Output (Voltage):	Up to ±10V DC
Output impedance (Voltage):	0.5 ohms
Output (Current)	±10mA into 120 ohms
Output Impedance (Current):	250 ohms
Package:	Standard M1000 series module

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5 Typical Input Circuits

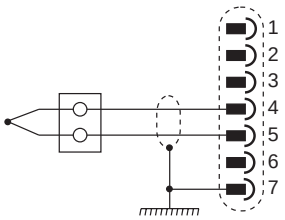

Figure 2 Thermocouple

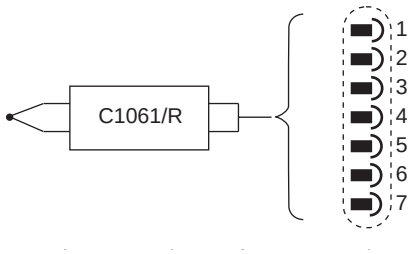

Figure 3 Thermocouple + Reference Junction

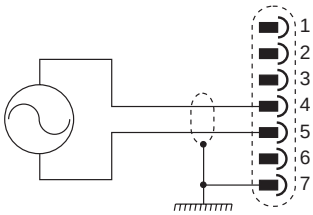

Figure 4 Analogue Signals

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6 Calibration

A true calibration of any system can only be achieved by applying a known physical stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc. The M1016 calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1061 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal switch on the recorder to Ch. No. The meter should now read 0.00V. Adjust using the Zero potentiometer.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control, as in b) above.

There are two further considerations regarding the zero condition:

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in b) above, the calibration is normally unaffected.

e) When the amplifier is switched from Run to Cal mode there may be a zero shift due to a change in the input conditions. This can be nulled as before without any effect on the calibration.

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6.1 Calibration Procedure

A typical calibration procedure for one channel would be as follows:

Example

It is required to scale the M1061 for:

0 - 100°C with a Type K thermocouple
0 - 100 mm deflection (recorders only)
0 - 2.00 volts (recorders and cabinets)

Before the calibration is started, the controls require presetting as follows:

M1061 Front Panel		
Offset Potentiometer		*
Range Switch		10mV
Fine Gain		*
Tape Potentiometer		*
Mode Switch		Cal
6 Pole DIP Switch		
1	For Type K thermocouple	ON
2	For Type T thermocouple	OFF
3	Unallocated thermocouple	OFF
4	Cal divided by 25	OFF
5	Low Pass Filter	OFF
6	Low Pass Filter	OFF
Monitor Unit Controls		
Monitor Range Switch		19.99
Monitor Ch. No./Cal switch		Cal
Galvo. On/Off switch		OFF
Channel		N
Bridge Voltage		*
Bridge On/Off		OFF
Calibrate +/Off/-		+
Calibrate Fine		*
Calibrate Range		10V

* Not Important

N Corresponding to channel being calibrated

Note: On the M12-150A the Galvo. ON/OFF switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

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1) From Type K thermocouple tables, the output of the thermocouple at 100°C = 4.10mV.

2) Adjust the Calibrate FINE potentiometer on the recorder to read 4.10 volts on the monitor.

3) Switch the Calibrate RANGE switch to 10mV. The voltage on the amplifier calibration terminals will now be 4.10mV. (This voltage cannot be measured accurately on the monitor and is achieved by means of a precision divider on the Range switch.)

4) If a recorder is being used, set the galvo. spot to 11 on the viewing scale.

Note: If all channels are not in use, it is preferable to use the centre channels for the best optical fidelity.

5) Set the Galvo. ON/OFF switch to ON. The amplifiers are now energised.

6) Monitor CH. No./CAL Switch to CH. No.
Monitor RANGE switch to 1.999V
Calibrate +/OFF/- switch to OFF

7) Use the OFFSET potentiometer to set the voltage monitor to 0.000V. Observe the galvo. spot, which should be at the position as set in 4), i.e. 11. If otherwise, the amplifier is faulty.

8) Set the Calibrate +/OFF/- switch to +. Use the FINE gain on the M1061 to adjust the galvo. spot to 1 on the viewing scale. Set the +/OFF/- switch to OFF. Check the galvo. spot has not moved from 11. If it has moved, repeat 7) and 8) until the spot can be moved from 11 to 1 using the Calibrate +/OFF/- switch in the OFF and + positions.

9) Return the Calibrate +/OFF/- switch to +, switch the monitor RANGE switch to 19.99V and adjust the TAPE potentiometer on the M1061 to read 2.00 volts on the monitor. (Repeat 7), 8) and 9) as required).

10) Set the Calibrate +/OFF/- switch to OFF, and the Bridge ON/OFF switch to ON. Observe the position of the galvo. spot and the monitor voltage. The values of both should correspond to the temperature of the C1061/R connector, typically 3 to 5°C above the ambient temperature, i.e. approximately 25°C. The deflection of the spot would be 25mm left of the position 11 and the voltmeter would read 0.50 volts.

11) Set the MODE switch to RUN, and the Bridge ON/OFF switch to OFF. Observe the spot and the monitor. The values observed should now be the difference between the temperature at the thermocouple and the temperature at the C1061/R.

e.g. If the thermocouple is in free air reading ambient temperature the reading will usuallly be negative due to the C1061/R being at a slightly higher temperature, i.e. the spot would be 3 to 5mm right of position 11 and the voltmeter would read - 0.03 to 0.05.

12) Set the Bridge ON/OFF switch to ON. The temperature as measured on the cold junction C1061/R is now added to the previous reading and the recorder and the monitor will indicate the temperature of the thermocouple in °C.

The system is now fully calibrated, operational and ready for use

Type		0°C	100°C	200°C	400°C	600°C	1000°C
K	Nickel Chromium/Nickel Aluminium	0	4.1	8.13	16.4	24.91	41.31
J	Iron/Constantan	0	5.37	10.95	22.1	33.67	-
T	Copper/Constantan	0	4.28	9.20	21.0	-	-

Table 1 Thermocouple types referenced to 0°C (millivolts)

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M1064 HIGH GAIN AMPLIFIER

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M1064 HIGH GAIN AMPLIFIER

1 Description

M1064 is a differential input instrumentation amplifier, featuring a wide bandwidth. It is designed for use with most types of low level sensors, strain gauges in 1, 2 or 4 active arm configurations, bonded and unbonded strain gauge transducers, load cells and other sensing devices. It accepts a full range of inputs from 1mV to 1.0 V and provides gains of up to 2000. The module features an output suitable to drive galvanometers and a seperately buffered voltage output to drive tape recorders, oscilloscopes, loggers and data acquisition systems

2 Front Panel Controls

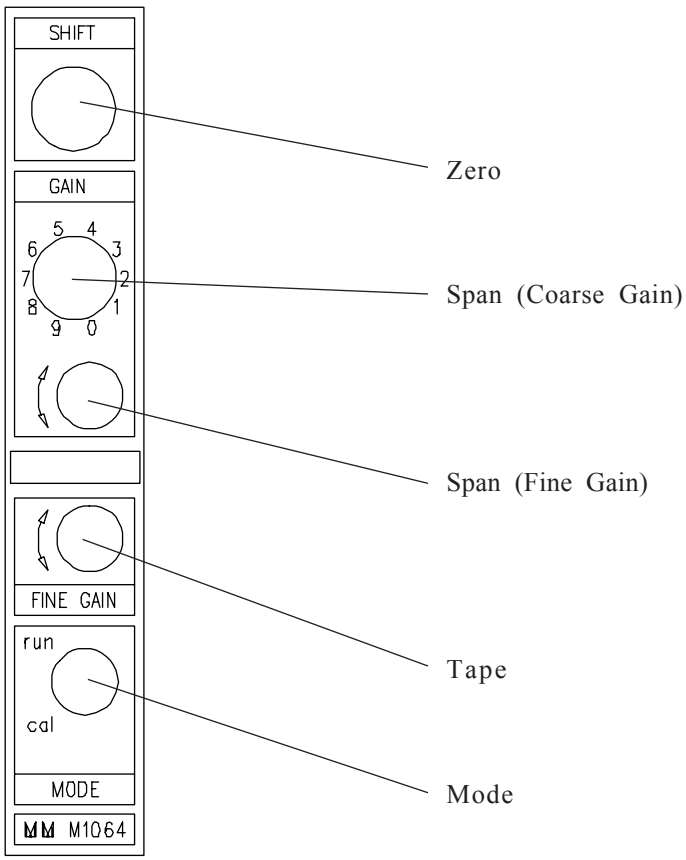

Figure 1 M1064 Front Panel

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2.1 Zero

This is a 15-turn potentiometer which functions as a bridge balance or input offset control. Its range is approximately ± 20mV at the input terminals (±4000 microstrain at 10V bridge excitation). This control is disabled when in the 'CAL' mode.

2.2 Span

The amplifier span (gain) is set by two controls, coarse and fine, which cover the approximate range 0.5 to 1000. The additional buffered voltage outpput provides an additional gain of up to 2.

Coarse Gain

The Coarse Gain control is a 10-position rotary switch calibrated such that in each successive position the gain is halved. The gain settings are shown including the additional buffered voltage output which incorporates a 2:1 adjustment on the fine gain and a 2:1 adjustment on the tape control. The full range is as follows:

Position	Max Gain	Min Gain
0	2000	500
1	1000	250
2	500	125
3	250	62
4	125	31
5	62	16
6	31	8
7	16	4
8	8	2
9	4	1

Maximum Dynamic range = 1 Volt at input

Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range. The control gives a 2:1 adjustment and is effective for the complete amplifier, that is both the galvo output and the voltage output.

2.3 Tape

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A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ± 10 Volts dc.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

* *Note*

When used in the 'CAL' position, the front panel 'Zero' control is disabled. The 'CAL' zero is preset on an internal adjustment.

3 Internal controls

3.1 Bridge Completion

The amplifier may be used with resistive bridge networks in the 1, 2 or 4 arm mode. In the 1 or 2 arm mode bridge completion is achieved by connecting dummy bridge arms within the amplifier by means of an internal switch (SW2).

The switch is a 6-pole 2-position type, of which poles 1, 2 and 3 are concerned with bridge conditioning. The dummy bridge arms should be switched in according to the input configuration, as follows:

Full Bridge: In this case the bridge is completed within the transducer, therefore poles 1, 2 and 3 should be in the Open position.

Half Bridge: Poles 1 and 2 are Closed, bringing in the two 499 ohm dummy arms. Pole 3 remains Open.

Quarter Bridge: Poles 1, 2 and 3 are Closed. Note that closing Pole 3 brings in R26, which is normally 350 ohms. If the resistance of the single external bridge arm is different from this value R26 must be changed to match it. (See also Typical Input Circuits).

3.2 Low Noise Operation

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To minimise output noise at high gains a low pass filter can be switched in by closing Poles 4 and 5 of SW2. This has the effect of reducing the bandwidth to approximately 9KHz.

4 Sensor Excitation

4.1 Transducer Supply

The 3 - 12V DC transducer supply is generated by the mainframe and appears on pins 1 and 2 of the amplifier. These are connected (via R29 and R30) to pins 3 and 4, which in turn are connected to pins 1 and 2 on the 7-pin Signal Input Connector at the rear of the instrument. Thus the transducer cannot be energised unless there is an amplifier present in that particular channel.

Note that the amplifier is normally supplied with R1 and R2 replaced by wire links so that the full supply (3 - 12V DC as selected by the Bridge Volts switch) appears across the transducer. However, if a reduced supply is required on a particular channel these may be replaced by resistors of the appropriate value to act as droppers in the supply lines.

For example: With 10V excitation selected, a particular strain gauge is required to be energised with 2.5V.

Bridge resistance = 350 ohms

Bridge excitation = 2.5V

Volt drop required = 7.5V

Therefore:

R29 + R30 = (350x7.5)/2.5 = 1050 ohms

So R29 and R30 are 525 ohms each.

Provision is also made to reverse the excitation polarity by means of links, (A or B), on the board, or of course this may also be achieved by reversing pins 1 and 2 on the Signal Input connector.

4.2 Zero Balance Range

Bridge balance is set by a 22-turn potentiometer which has a nominal range of ±20mV at the input (±4000 microstrain for 10V bridge excitation).

5 Voltage Output Range

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The amplifier has a separate buffered voltage output which appears on the Voltage Output socket on the rear of the instrument. The nominal output can be adjusted by means of the potentiometer marked Fine Gain to between ±5V and ±10V maximum output swing.For certain applications, such as driving a Tape Recorder, it may be necessary to limit the output swing to ±2V. This may be achieved by closing Pole 6 of SW2, which attenuates the output by 5:1. The Tape adjustment can then be used for fine tuning.

6 Specification

Input Configuration:	High Gain Differential
Input Impedance:	1 Megohm Differential
Input Mode:	1) Resistive bridge in 1, 2 or 4 arm connection with internal bridge completion.
	2) Low level signals generally.
Input Range:	Up to 1 V (approx.)
Zero Offset Range	+/- 20mV r.t.i
Maximum Input:	15V D.C.
Common Mode Rejection:	90dB (D.C. to 60 Hz)
Noise: (Up to 10KHz)	Less than 5 microvolts r.m.s.(r.t.i.) at max. gain.
Drift:	Less than 2 microvolts/°C (r.t.i.) at max. gain.
Bandwidth: (-3dB)	100Khz at Max gain
Bandwidth: (-1dB)	50KHz at max gain
Gain:	1 to 2000 in switched steps with interpolate control.
Output (Voltage):	Up to ±10V DC
Output impedance (Voltage):	0.5 ohms
Output (Galvo)	±10mA into 120 ohms
Output Impedance (Galvo):	250 ohms
Package:	Standard M1000 series module

7 Typical Input Circuits

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Figure 2 Strain Gauge

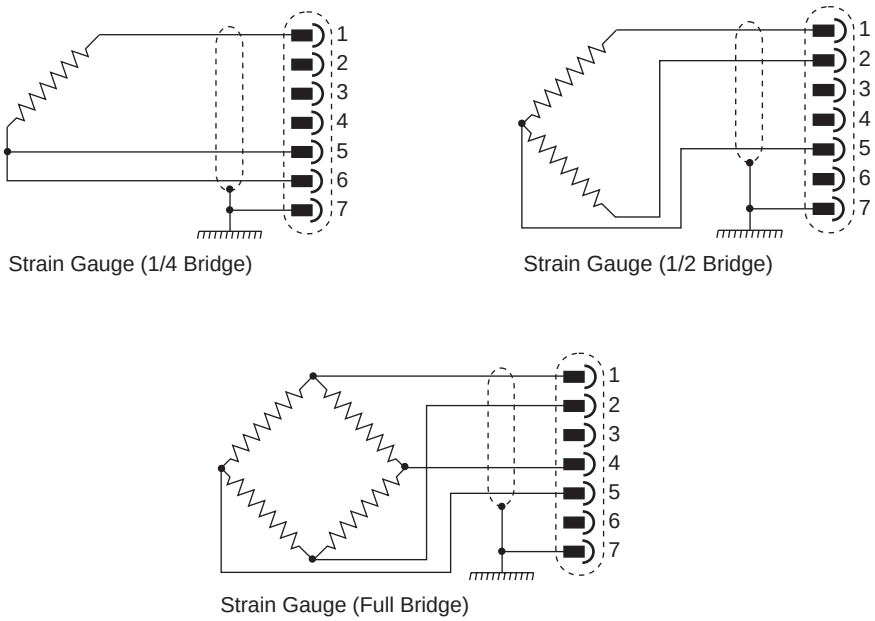


Figure 3 Analogue Signals

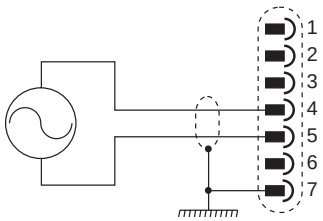
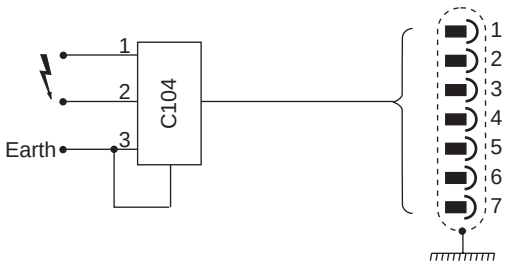


Figure 4 High Voltage



8 Calibration

A true calibration of any system can only be achieved by applying a known physical

stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc.

The Micro Movements mainframe calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1064 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal switch on the recorder to Ch. No. The meter should now read 0.00V.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control.

Note 1) When the transducer is disconnected a zero offset is observed which has the opposite polarity to the sensor offset.

Note 2) When using the 'CAL' mode on the M1064 the zero offset is supressed (the zero control has no effect) to obtain an output proportional to calibration voltage only.

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in c) above, the calibration is normally unaffected.

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Mode Switch (Amplifier)

This is a 2-pole changeover switch connected to the amplifier input terminals.

- In the Operation (RUN) position the amplifier input is connected directly to the signal source (usually a transducer) via pins 4 and 5 on the Signal Input connector at the rear of the instrument.

- In the Calibration (CAL) position the input is connected to a calibration voltage derived from the recorder or signal conditioning cabinet.

8.1 Calibration Procedure

A typical example calibration procedure for one channel would be as follows:

Take a pressure transducer with a nominal output of 40mV for full scale pressure with 10V excitation (typical for an unbonded strain gauge type). However, it is unlikely that any particular transducer would have an output of exactly 40mV, more likely it would be somewhere within ±10% of this value. So, we look at the manufacturers calibration certificate supplied with the transducer and see that this is a 75 PSI unit which has an output of +38.68mV at 75 PSI if energised with a 10V DC supply.

Note: If energised by a different supply the output is normally pro-rata but the temperature coefficient is sometimes degraded.

The transducer has a zero imbalance (i.e. an output when no pressure is applied) of -2.97mV. Therefore the total output change for 75 PSI applied is the sum of these two (because the zero imbalance happens to be negative):

38.68 + 2.97 = 41.65mV.

Preset the controls as follows:

M1064 Front Panel Controls

Zero Balance Potentiometer *

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Range Switch :		5
Fine Gain		Fully Counter-clockwise
Tape Control		Fully Counter-clockwise
Run/Cal Switch		Cal
DIP Switch		
1	Half Bridge	OFF
2	Half Bridge	OFF
3	Quarter Bridge	OFF
4	Low Pass Filter	OFF
5	Low Pass Filter	OFF
6	+/- 2 V limit	OFF
Mainframe Monitor Unit Controls		
Monitor Range Switch		19.99
Monitor Ch. No./Cal Switch		Cal
Galvo. On/Off		OFF
Channel		N
Bridge Voltage		
(as required for transducer)		10V
Bridge On/Off		OFF
Calibrate +/OFF/-		+
Calibrate Fine		*
Calibrate Range		10V

* Not Important

N Corresponding to channel being calibrated

Note: This feature is not fitted to M1000-6.

1) Using the Calibrate FINE potentiometer set the voltage on the Monitor to 4.17V.

2) Turn Calibrate RANGE to 100mV. There will now be 41.7mV on the mainframe calibration bus.

3) Recorders only. Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

Note: If all channels are not in use, it is preferable to use the centre channels for the best optical fidelity.

4) Galvo. ON/OFF switch to ON. (This switch provides power to the amplifiers.)
Calibrate +/OFF/- switch to OFF
Monitor CH. No./CAL switch to CH. No.

5) You should read 0.00V on the monitor. {For recorders, also observe the galvo. spot, it should correspond to the position set in 3) i.e. 11. If there is a discrepancy, recheck, as either the amplifier is faulty or there has been a

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wrong setting.}

6) Calibrate +/OFF/- switch to +.

For recorders, adjust the spot deflection to 7.5cm. using the FINE gain control on the amplifier.

For amplifier housings only adjust the fine control fully clockwise.

7) Using the TAPE potentiometer on the amplifier, set the monitor voltage to a suitable value, e.g. 2.00V. At this stage the system has been calibrated for a sensitivity of 1cm/10 PSI on the recorder and a voltage output of 200mV per 10 PSI.

8) Calibrate +/OFF/- switch to OFF.

Check that zero is still true

9) RUN/CAL switch on the amplifier to RUN.

Check that zero is still true

10) Bridge ON/OFF switch to ON

The zero will almost certainly move due to residual offset. Use the Zero control to reset the output shown on the Monitor to 0.00V. For recorders this should correspond to the spot in the original zero position, i.e. 11 on the graticule

11) The system is now fully calibrated and ready for use. For recorders, if a different position is preferred for the galvo. mechanical zero, set the Galvo. ON/OFF switch to the OFF position before moving the galvo. Return the switch to ON after the galvo. has been set.

Note If, after step 10), the galvo. or voltmeter are completely off scale note the position of the range switch and temporarily reduce the gain of the amplifier by turning the range switch counter-clockwise one or two positions until the monitor voltage reduces and/or the spot is visible and then re-balance. If it still cannot be re-balanced there must be a fault in the bridge circuit, all four arms of the bridge should be checked at the free connector.

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M1070 ATTENUATOR/AMPLIFIER

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M1070 ATTENUATOR/AMPLIFIER

1 Description

The M1070 is a general purpose attenuator/low-gain amplifier module for operation with high level sensors such as DC/DC LVDTs, servo accelerometers, etc. and signals generally in the 25mV to 100V range. (For high voltage measurements a special attenuator plug is available, see documentation on C104 High Voltage Connector.)

Features include high input impedance, low noise and drift, with input protection up to 125V differential.

2 Front Panel Controls

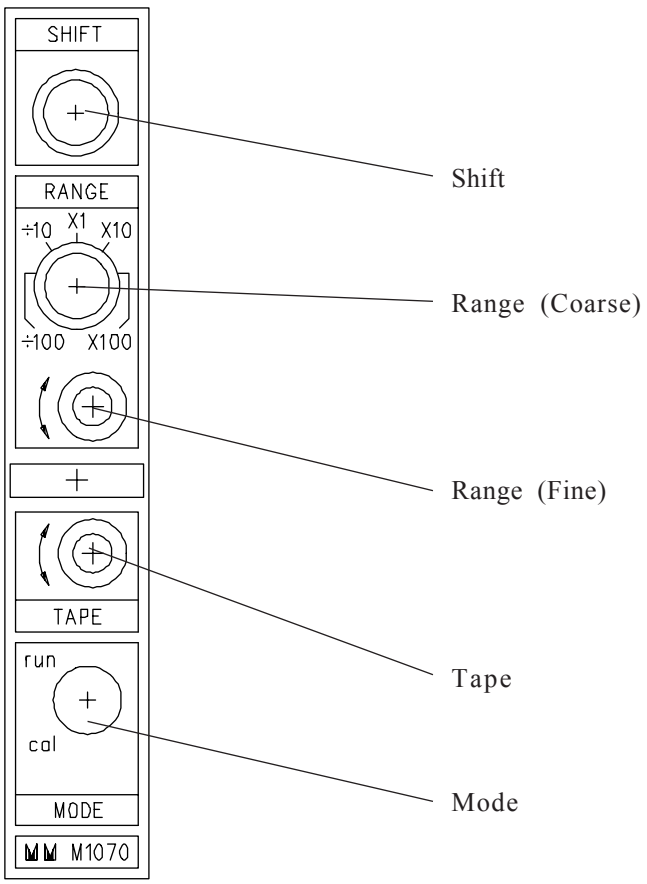

Figure 1 M1070 Front Panel

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2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or input offset control enabling the output to be shifted over plus and minus full scale.

2.2 Range

The gain/attenuation range of the amplifier is set by two controls, coarse and fine, which cover the range; divide by 100 to multiplied by 100.

Coarse Gain

The coarse control is a 5-position rotary switch calibrated directly in gain, the actual sensitivity obtained being a function of the galvanometer type:

Indicated Range	**Typical Input Voltage for 5cm deflection**	
	Max. (fine gain fully counter-clockwise)	**Min. (fine gain fully clockwise)**
“100	*	75V
“10	75V	7.5V
x1	7.5V	750mV
x10	750mV	75mV
x100	75mV	7.5mV

* see section 5

Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range.

2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ±2V DC.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

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3 Internal controls

3.1 Bridge Completion

The amplifier may be used with resistive bridge networks in the 1, 2 or 4 arm mode. In the 1 or 2 arm mode, bridge completion is achieved by connecting dummy arms within the amplifier by means of an internal switch (SW2).

The switch is a 6-pole 2-position type, of which poles 1, 2 and 3 are concerned with bridge conditioning, as follows:

Full Bridge: In this case the bridge is completed within the transducer, therefore poles 1, 2 and 3 should be in the Open or OFF position.

Half Bridge: Poles 1 and 2 are ON, bringing in two 499 ohm dummy arms (R1 and R2). Pole 3 remains Open.

Quarter Bridge: Poles 1, 2 and 3 are ON. Note that closing Pole 3 brings in R3, which is normally 120 ohms. If the resistance of the single external bridge arm is different from this value R3 must be changed to match it. (See Typical Input Circuits)

3.2 Low Noise Operation

To minimise output noise at high gains a low pass filter can be switched in by closing Poles 4 and 5 of SW2. This, however, has the effect of reducing the bandwidth to approximately 150Hz.

3.3 Ground Reference

In applications where the signal source has no connection to ground, (e.g. battery operated systems), it may be desirable to connect the Input LO of the amplifier to ground internally for best noise performance. Pole 6 of SW2 gives this connection when switched to the ON position.

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4 Sensor Excitation

4.1 Transducer Supply

The 3 - 12V DC transducer supply (M1015) appears on pins 1 and 2 of the amplifier. These are connected (via R1 and R2) to pins 3 and 4, which in turn are connected to pins 1 and 2 on the 7-pin Signal Input Connector at the rear of the instrument. Thus the transducer cannot be energised unless there is an amplifier present in that particular channel. Note that the amplifier is normally supplied with R1 and R2 replaced by wire links so that the full supply (3 - 12V DC as selected by the Bridge Volts switch) appears across the transducer. However, if a reduced supply is required on a particular channel these may be replaced by resistors of the appropriate value to act as droppers in the supply lines.

For example: With 10V excitation selected, a particular strain gauge is required to be energised with 2.5V.

Bridge resistance = 120 ohms

Bridge excitation = 2.5V

Volt drop required = 7.5V

Therefore:

R1 + R2 = (120x7.5)/2.5 = 360 ohms

So R1 and R2 are 180 ohms each.

Provision is also made to route out the amplifier power supply rails by selection of links (B) on the board. These connect the +12V rail to pin 3, the 0V rail to pin 9 and the -12V rail to pin 4. These in turn are connected to the Signal Input connector on pins 1, 6 and 2 respectively.

Amplifiers supplied from the factory with this connection are designated M1070/S11 and are marked with two brown dots on the handle.

4.2 Zero Balance Range

Bridge balance is set by a 22-turn potentiometer which has a nominal range of ±20mV at the input (±4000 microstrain for 10V bridge excitation). For transducers with a very large residual imbalance the range of this control may be increased by the adjustment of R10.

5 High Voltage Operation

A special connector, type C104, with a built-in balanced attenuator can be used to extend the input range up to 250V r.m.s. (See documentation on C104 High Voltage Connector).

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6 Specification

Input Configuration:	Low Gain Differential
Input Impedance:	220 Kohm Differential
Input Mode:	1) Resistive bridge in 1, 2 or 4 arm connection with internal bridge completion. 2) Medium/high level signals generally.
Input Range:	Up to 500 mV (approx.)
Maximum Input:	125V D.C. (up to 250V r.m.s with adaptor type C104)
Noise:	Less than 20 microvolts r.m.s.(r.t.i.).
Drift:	Less than 20 microvolts/°C (r.t.i.).
Bandwidth:	D.C. - 10KHz.
Gain:	"100 - x100 in 5 switched steps with interpolate control.
Output (Voltage):	Up to ±10V DC
Output impedance (Voltage):	0.5 ohms
Output (Current)	±10mA into 120 ohms
Output Impedance (Current):	250 ohms
Package:	Standard M1000 series module

7 Typical Input Circuits

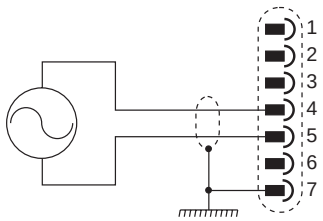

Figure 2 Analogue Signals

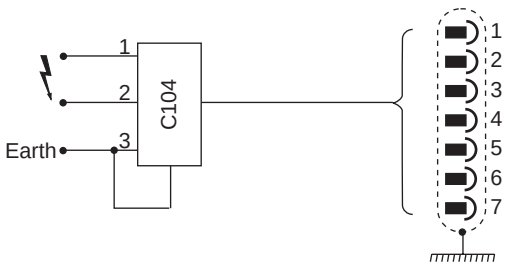

Figure 3 High Voltage

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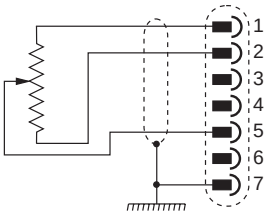

Figure 4 Potentiometric

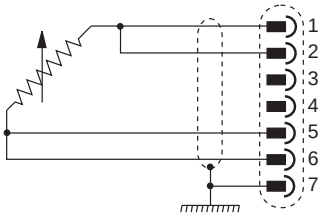

Figure 5 Resistance Thermometer

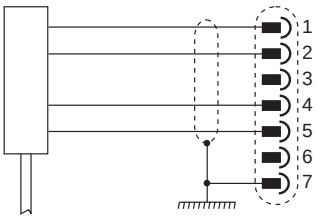

Figure 6 DC/DC LVDT

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8 Calibration

A true calibration of any system can only be achieved by applying a known physical stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc. The M1016 calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1060 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal switch on the recorder to Ch. No. The meter should now read 0.00V. Adjust using the Zero potentiometer.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control, as in b) above.

There are two further considerations regarding the zero condition:

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in b) above, the calibration is normally unaffected.

e) When the amplifier is switched from Run to Cal mode there may be a zero shift due to a change in the input conditions. This can be nulled as before without any effect on the calibration.

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8.1 Calibration Procedure

A typical calibration procedure for one channel would be as follows:

Example

It is required to calibrate the recorder for a 1.000 volts input to give 10cm deflection on the galvanometer and 2.00 volts on the Tape output.

Preset the controls as follows:

M1070 Front Panel Controls		
Shift Potentiometer		*
Range Switch		x 10
Fine Gain		Fully Counter-clockwise
Tape Control		Fully Counter-clockwise
Mode Switch		Cal
6-Pole DIP switch		
1	Half Bridge	OFF
2	Half Bridge	OFF
3	Quarter Bridge	OFF
4	150 Hz low pass filter	OFF
5	150 Hz low pass filter	OFF
6	Ground Input Lo	OFF
Monitor Unit Controls		
Monitor Range Switch		1.999
Monitor Ch. No./Cal switch		Cal
Galvo. On/Off switch		OFF
Channel		N
Bridge Voltage		*
Bridge On/Off		OFF
Calibrate +/OFF/-		+
Calibrate Fine		*
Calibrate Range		1V

* Not Important

N Corresponds to channel being calibrated

Note: On the M12-150A the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

Some versions of the M1070 have a higher gain than others and in this case the range switch should be in the X1 position to give the correct gain for the example.

1) Use the Calibrate FINE potentiometer to set the Cal voltage to 1.000 volts on the monitor.

2) Recorders only - Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

Note: If all channels are not in use it is preferable to use the centre channels for the best optical fidelity, e.g. Channels 3 through to 7.)

3) Set the Galvo. ON/OFF switch to ON. (This switch provides power to the amplifiers.)
Set the Calibrate +/OFF/- switch to OFF
Set the Monitor CH. No./CAL switch to CH. No.
Set the Monitor 1.999/19.99 switch to 19.99

4) Adjust the SHIFT potentiometer on the amplifier to give 0.00V on the monitor. Observe the galvo, it should correspond to the position set in 2), i.e. 11. If there is a discrepancy recheck the procedure, as either the amplifier is faulty or there has been a wrong setting.

5) Set the Calibrate +/OFF/- switch to +. For recorders use the FINE gain control on the amplifier to set the galvo. spot to position 1, i.e. a deflection of 10cm from 11.

6) Use the TAPE potentiometer on the amplifier to set the monitor voltage to 2.00 volts. At this stage, the system has been calibrated for a sensitivity of 10cm/volt on the recorder and 2.00 volts/volt on the voltage output.

7) Set the Calibrate +/OFF/- swtich to OFF. If there has been a change from the original setting of 11 on the chart scale or 0.00V on the monitor repeat the above procedure from the original preset values in order to fine tune the system.

8) Set the RUN/CAL switch on the amplifier to RUN. The recorder will now read directly the voltage at the input connector scaled as in 7).

If the galvo. spot is off scale, turn the range switch on the amplifier to x 1. This will reduce the original setting by a factor of 10, thus indicating the input voltage as calibrated x 10.

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M1073 R.M.S./D.C. CONVERTER

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M1073 R.M.S./D.C. CONVERTER

1 Description

The M1073 is an R.M.S./D.C. Converter that accepts AC inputs in the range 10mV r.m.s. to 100V RMS and provides a DC signal to the galvanometer and tape outputs. Typical inputs would be from current transformers, tape replay amplifiers, 50/60Hz and 400Hz power lines, etc. (see also section 4).

2 Front Panel Controls

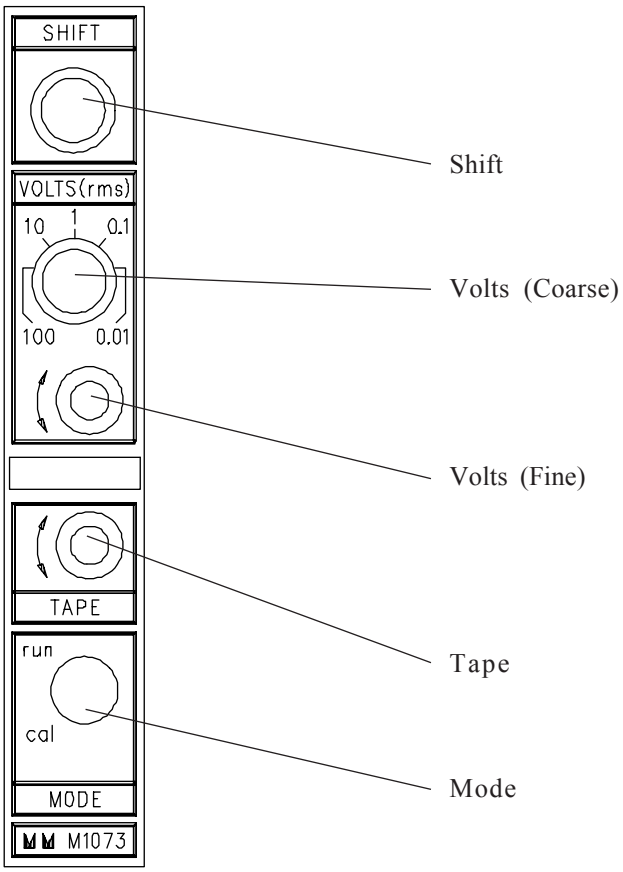

Figure 1 M1073 Front Panel

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2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or input offset control enabling the output to be shifted over plus and minus full scale on the chart.

2.2 Volts

The gain/attenuation range of the amplifier is set by two controls, coarse and fine, which cover the range 10mV to 100V r.m.s..

Coarse

The coarse control is a 5 position switch calibrated directly in volts.

Indicated Range	**Typical input voltage range for 5cm deflection with M1600 type galvanometer**	
	Max. (fine control fully counter-clockwise)	**Min. (fine control fully clockwise)**
0.01V	45mV	4mV
0.1V	450mV	40mV
1V	4.5V	400mV
100V	*	40V

* The input voltage cannot exceed 125V r.m.s.. It is however, often necessary to reduce the deflection to less than full scale for the maximum of 125V r.m.s.. (See High Voltage Operation).

Fine

The fine interpolation control covers a 10:1 range.

2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Outputs connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the front panel to give up to 2V DC output.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 7).

In the Calibration (CAL) position the amplifier is connected directly to the AC calibration signals on pins 15 and 16 of the amplifier connector.

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The AC calibration is connected to the 13.8V AC 50Hz transformer winding and therefore is limited in application.

For accurate calibration, an external signal generator and AC reading digital voltmeter are necessary.

3 Functional Description

The module consists of an attenuator followed by a differential amplifier. The output of the differential amplifier feeds a precision rectifier which is followed by a two pole Butterworth Filter. The filter is set to give 1% ripple on a 50Hz signal.

4 High Voltage Operation

A special connector, type C104, with a built in balanced attenuator can be used to extend the input range up to 250V r.m.s. (See documentation for C104 High Voltage Attenuator).

5 Specification

Input Range:	10mV to 100V r.m.s.
Input Frequency:	50Hz to 10kHz
Input Impedance:	220k ohms differential
Attenuator (Coarse):	5 positions; 10mV, 100mV, 1V, 10V, 100V
Attenuator (Fine):	Interpolates 10:1 range
Output (Voltage):	Up to ±10V DC
Output Impedance (Voltage):	0.5 ohms
Output (Current):	±10mA into 30 ohms
Output Impedance: (Current)	250 ohms
Maximum Input:	100V r.m.s.
Linearity:	±0.5%

6 Typical Input Circuits

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Figure 2 Analogue Signals

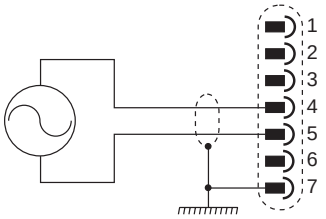


Figure 3 Current Transformer

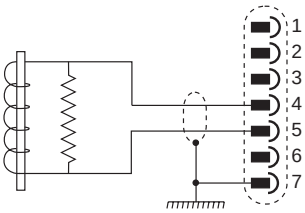
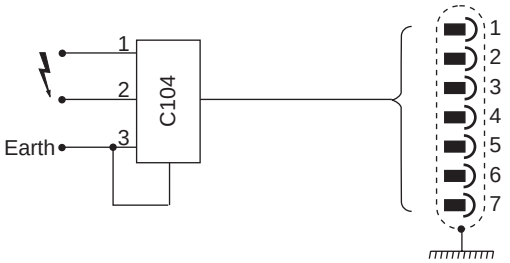


Figure 4 High Voltage



7 Calibration

7 Calibration

7.1 Calibration Procedure

It is required to calibrate the recorder for a 1V r.m.s. input to give 10cm deflection on the galvanometer and 2.00 volts on the tape output.

The controls are preset to the following:

M1073 Front Panel Controls	
Shift Control	*
Volts (RMS) Switch	1V
Fine Gain	Fully counter-clockwise
Tape Potentiometer	Fully counter-clockwise
Mode Switch	Cal
M1086 Front Panel Controls	
Range Switch	OFF
Monitor Unit Controls	
Range Switch	1.999V
Ch. No./Cal. Switch	Ch. No.
Galvo. On/Off Switch	OFF
Channel	N
Bridge Voltage	*
Bridge On/Off	OFF
Calibrate +/OFF/-	OFF
Calibrate Fine	*
Calibrate Range	*

* Not Important

N Corresponding to channel being calibrated

Note: On the M12-150A the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to the M1000-6.

1) Recorders Only

   Use the galvanometer tool to rotate the spot to position 11 on the viewing scale.

Note: If all channels are not in use it is preferable to use the centre channels for the best optical fidelity.)

2) Set the Galvo. On/Off switch to ON. This switch provides power to the amplifiers.

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3) Adjust the shift control on the amplifier to give 0.000V on the monitor. Observe the galvo., it should correspond to the position set in 2), i.e. 11. If there is a discrepancy, recheck the procedure, as either there has been a wrong setting or the amplifier is faulty.

4) Set the Range switch on the M1086 to 1.00V r.m.s.. For recorders use the Fine Gain Control on the M1073 module to set the galvo. spot to position 1, i.e. a deflection of 10cm from 11.

5) Use the Tape control on the M1073 to set the monitor voltage to 2.00V. At this stage, the system has been calibrated for a sensitivity of 10cm/V on the recorder and 2.00 volts/volt on the voltage output.

6) Set the Run/Cal switch on the amplifier to RUN. The recorder will now read directly the voltage at the input connector scaled as in 5). If the galvo. spot is off scale or the monitor is reading over 1.999 volts, turn the range switch on the amplifier to 10. This will reduce the original setting by a factor of 10, thus indicating the input voltage as calibrated x 10.

7) Turn the Range switch on the M1086 to OFF.

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M1079 ISOLATED ATTENUATOR/AMPLIFIER

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M1079 ATTENUATOR/AMPLIFIER

1 Description

The M1079 is a general purpose isolated attenuator/amplifier module for operation with voltage inputs in the range 10mV to 100V. (For high voltage measurements a special attenuator plug is available, see documentation on C103 and C104 High Voltage Connector.)

Features include high input impedance, low noise and drift, with galvanic isolation on the inputs.

2 Front Panel Controls

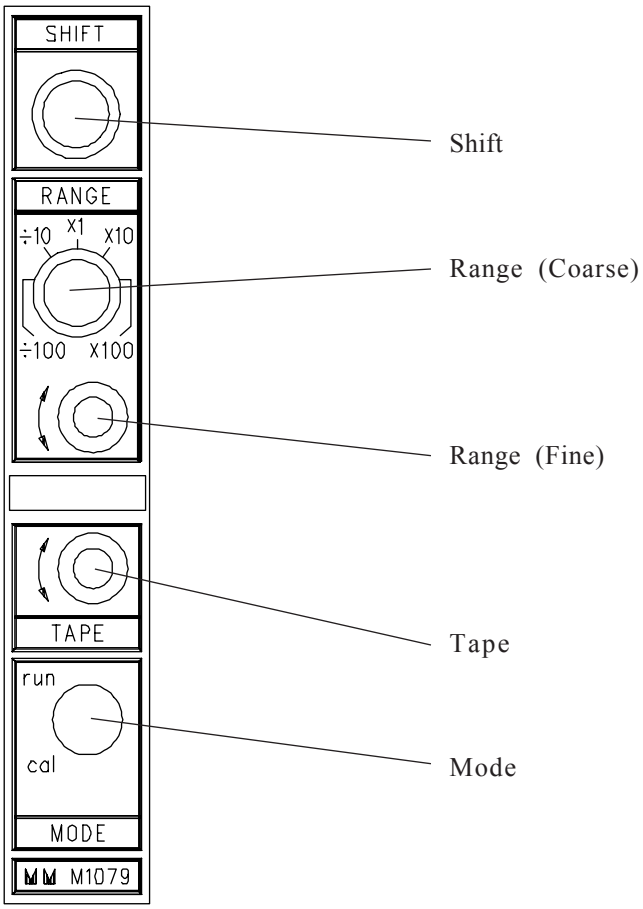

Figure 1 M1079 Front Panel

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2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or input offset control enabling the output to be shifted over plus and minus full scale.

2.2 Range

The gain/attenuation range of the amplifier is set by two controls, coarse and fine, which cover the range; divide by 100 to multiplied by 100.

Coarse Gain

The coarse control is a 5-position rotary switch calibrated directly in gain, the actual sensitivity obtained being a function of the galvanometer type:

Indicated Range	**Typical Input Voltage for 5cm deflection**	
	Max. (fine gain fully counter-clockwise)	**Min. (fine gain fully clockwise)**
“100	*	75V
“10	75V	7.5V
x1	7.5V	750mV
x10	750mV	75mV
x100	75mV	7.5mV

* see section 5

Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range.

2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ±10V DC.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the input via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

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3 Internal Controls

None available on this module

4 Sensor Excitation

4.1 Transducer Supply

Not available on this module

4.2 Zero Balance Range

Bridge balance is set by a 22-turn potentiometer which has a nominal range of ±10V at the output.

5 High Voltage Operation

A special connector, types C103 or C104, with a built-in balanced attenuator can be used to extend the input range up to 250V r.m.s. (See documentation on C103/ C104 High Voltage Connector).

6 Specification

Input Configuration:	Isolated Differential
Input Impedance:	> 2Mohm Differential
Maximum Input:	100V D.C.
Noise:	Less than 20 µV +4µV$\sqrt{Hz}$
Drift:	Less than 20 µ/°C (r.t.i.).
Gain:	÷100 - x100 in 5 switched steps with interpolate control.
Offset	± 10 V at output
Bandwidth	2 KHz (10KHz maximum)
Isolation Voltage	1000 V
CMRR	> 60dB
IMRR	> 100dB
Output (Voltage):	Up to ± 10V DC
Output impedance (Voltage):	0.5 ohms
Output (Galvo)	±10mA into 120 ohms
Output Impedance (Galvo):	250 ohms
Package:	Standard M1000 series module

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7 Typical Input Circuits

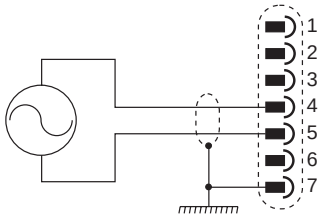

Figure 2 Analogue Signals

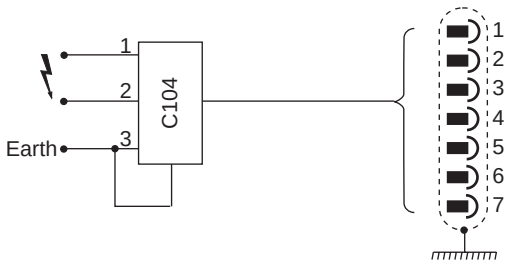

Figure 3 High Voltage

7.1. Input Connections

7 Pin Din Connector

PIN NO	FUNCTION
1	Not Connected
2	Not Connected
3	Not Connected
4	Input Low
5	Input High
6	Isolated Ground
7	Earth

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8 Calibration

A true calibration of any system can only be achieved by applying a known physical stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc. The M1016 calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1060 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal switch on the recorder to Ch. No. The meter should now read 0.00V. Adjust using the Zero potentiometer.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control, as in b) above.

There are two further considerations regarding the zero condition:

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in b) above, the calibration is normally unaffected.

e) When the amplifier is switched from Run to Cal mode there may be a zero shift due to a change in the input conditions. This can be nulled as before without any effect on the calibration.

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8.1 Calibration Procedure

A typical calibration procedure for one channel would be as follows:

Example

It is required to calibrate the recorder for a 1.0 volts input to give 10cm deflection on the galvanometer and 10.0 volts on the Tape output.

Preset the controls as follows:

M1079 Front Panel Controls

Shift Potentiometer	*
Range Switch	x 10
Fine Gain	Fully Counter-clockwise
Tape Control	Fully Counter-clockwise
Mode Switch	Cal

Monitor Unit Controls

Monitor Range Switch	1.999
Monitor Ch. No./Cal switch	Cal
Galvo. On/Off switch	OFF
Channel	N
Bridge Voltage	*
Bridge On/Off	OFF
Calibrate +/OFF/-	+
Calibrate Fine	*
Calibrate Range	1V

* Not Important

N Corresponds to channel being calibrated

Note: On the M12-150A the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

Some versions of the M1079 have a higher gain than others and in this case the range switch should be in the X1 position to give the correct gain for the example.

1) Use the Calibrate FINE potentiometer to set the Cal voltage to 1.000 volts on the monitor.

2) Recorders only - Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

Note: If all channels are not in use it is preferable to use the centre channels for the best optical fidelity, e.g. Channels 3 through to 7.)

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3) Set the Galvo. ON/OFF switch to ON. (This switch provides power to the amplifiers.)
Set the Calibrate +/OFF/- switch to OFF
Set the Monitor CH. No./CAL switch to CH. No.
Set the Monitor 1.999/19.99 switch to 19.99

4) Adjust the SHIFT potentiometer on the amplifier to give 0.00V on the monitor. Observe the galvo, it should correspond to the position set in 2), i.e. 11. If there is a discrepancy recheck the procedure, as either the amplifier is faulty or there has been a wrong setting.

5) Set the Calibrate +/OFF/- switch to +. For recorders use the FINE gain control on the amplifier to set the galvo. spot to position 1, i.e. a deflection of 10cm from 11.

6) Use the TAPE potentiometer on the amplifier to set the monitor voltage to 2.00 volts. At this stage, the system has been calibrated for a sensitivity of 10cm/volt on the recorder and 2.00 volts/volt on the voltage output.

7) Set the Calibrate +/OFF/- swtich to OFF. If there has been a change from the original setting of 11 on the chart scale or 0.00V on the monitor repeat the above procedure from the original preset values in order to fine tune the system.

8) Set the RUN/CAL switch on the amplifier to RUN. The recorder will now read directly the voltage at the input connector scaled as in 7).

If the galvo. spot is off scale, turn the range switch on the amplifier to x 1. This will reduce the original setting by a factor of 10, thus indicating the input voltage as calibrated x 10.

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M1080 FREQUENCY/D.C. CONVERTER

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M1080 FREQUENCY/D.C. CONVERTER

1 Description

The M1080 Frequency/DC Converter produces a DC output signal proportional to the frequency of the input signal. The input may be a dynamic waveform from 10mV r.m.s. to 100V r.m.s.. Applications include flow measurement (impeller flowmeters), photo-electric and magnetic shaft speed sensors and AC tachometers.

2 Front Panel Controls

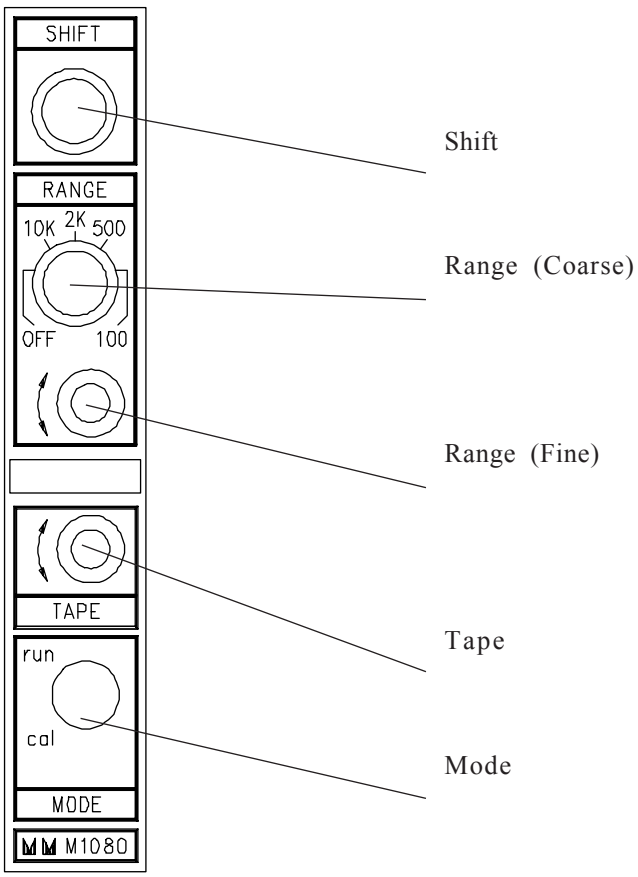

Figure 1 M1080 Front Panel

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2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or output offset control on the current output, enabling the output to be shifted over plus or minus full scale output.

2.2 Volts

The frequency range over which the unit will operate is determined by two controls, coarse and fine.

Coarse

The coarse control is a rotary switch calibrated directly in input frequency.

Typical Deflection of M1600 galvanometer:

	Input Frequency	
Position of fine gain potentiometer	**As indicated on range switch**	**20% of indicated range**
Fully clockwise	55cm	11cm
Fully counter-clockwise	5cm	1cm

Fine

The fine control is a 15-turn potentiometer with a 5:1 range which interpolates the switched steps.

2.3 Tape

A 15-turn potentiometer is used to adjust the voltage output of the amplifier independent of the galvanometer output. The tape voltage output can be used to drive recorders, oscilloscopes, digital voltmeters or other voltage driven devices. The output voltage is adjustable up to 2V DC.

2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 7).

In the Calibration (CAL) position the input is connected to a calibration signal. The source of this calibration signal is described in section 3.

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3 Internal Controls

A 6-pole dual-in-line (DIL) switch (SW2) is mounted on the printed circuit board, this switch is accessible through a cut-out in the side of the amplifier cover.

SW2/1 (Optional Offset)

An optional offset can be fitted to the Frequency to DC Converter. This is of value for measuring variations on a fixed frequency, e.g. frequency variations of 50/60Hz power lines or 400Hz aircraft supplies. This is a factory fitted option designated M1080/S33 and can be identified by two orange dots on the handle. See the section titled Offset Zero.

SW2/2, 3 and 4 (Filter Time Constant)

Range	Filter Time Constant			
	Poles 2, 3, 4 open	Pole 2 closed	Poles 2, 3 closed	Poles 2, 3, 4 closed
OFF	-	-	-	-
10 kHz	75mS	35mS	15mS	5mS
2kHz	300mS	140mS	60mS	20mS
500Hz	1.5S	700mS	300mS	100mS
100Hz	7.5S	3.5S	1.5S	500mS

The units are dispatched with poles 2, 3 and 4 open, i.e. the longest time constant. Other combinations of filtering can be achieved by a combination of the 3 poles of SW2 being utilised.

SW2/5 and 6 (Internal/External Cal.)

The calibration is normally internal with SW2/5 closed and SW2/6 open. In this case the calibration is derived from the power supply frequency, i.e. 50/60Hz or 400Hz when used on DC power. (This calibration facility is of limited value for operation at frequencies above 1kHz.)

A crystal-controlled frequency calibrator is available, the M1085, which has 9 calibration frequencies from 20Hz to 10kHz. When an M1085 is fitted the calibration signal is available on pin 16 of all the modules and can be switched to the Calibration Input of the M1080 by closing SW2/6 and opening SW2/5.

Note: If poles 5 and 6 are both closed, damage will not occur but the result will be incorrect.

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4 Tranducer Excitation

The ±12V power supply can be routed through the module to the rear panel of the recorder thus providing excitation for optical pick-ups, etc. (M1080/S9).

5 Photo-Electric Pick-Ups

It is common for PEP outputs to be unidirectional. Pins are provided for an offset to the input so that the input is driven by a unidirectional signal. e.g. If the input is a TTL compatible positive square wave, connect a 47k ohms resistor across D4, thus giving a -2V bias to the input.

6 Offset Zero

Many applications require an offset zero facility e.g. in monitoring 50Hz or 400Hz power supplies to record a deviation of ±10%.

The DIL switch position 1 provides an offset zero when closed. The value of the offset is controlled by AOT resistor R23 and potentiometer VR4. In the offset mode, it is not always possible to obtain the required gain in the system, e.g. ±10% is only one fifth of the normal output. A provision to increase the gain is provided by R12.

R12 - Normally open circuit

R12 - 4k7 (Increases gain by 2)

R12 - 2k2 (Increases gain by 3)

R12 - 1k2 (Increases gain by 5)

Note: Further gain increases will reduce the stability of the system.

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7 Specification

Input Configuration:	Single ended
Input Impedance:	10k ohms
Input Mode:	1) Sinewave from impeller flowmeters, RPM pick-ups, etc. 2) Square wave TTL.
Input Range:	10mV to 100V r.m.s.
Maximum Input:	100V r.m.s. (up to 250V r.m.s. with C104 adaptor).
Drift:	±0.01%/°C Referred to Output
Bandwidth:	1Hz to 10Hz
Full Scale Range:	Off, 10kHz, 2kHz, 500Hz, 100Hz with interpolate control.
Output Voltage:	Up to ±10V DC
Output Impedance (Voltage):	0.5 ohms
Output Current:	±10mA into 120 ohms
Output Impedance (Current):	250 ohms
Filters:	From 5 mS to 7.5S (See Filter Time Constant Table.)
Shift:	±10mA on current output
Package:	Standard M1000 series module.

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8 Typical Input Circuits

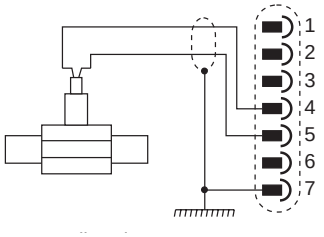

Figure 2 Impeller Flowmeter

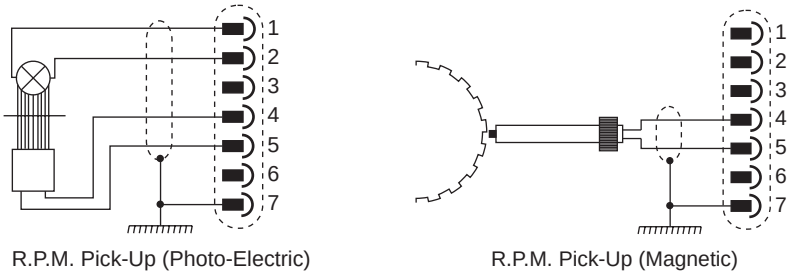

Figure 3 R.P.M. Pick-up

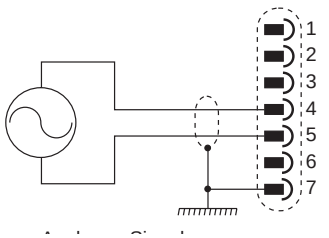

Figure 4 Analogue Signals

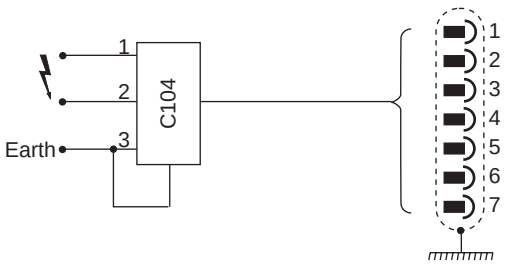

Figure 5 High Voltage

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9 Calibration

To achieve accurate calibration an M1085 Frequency Calibrator must be used.

9.1 Calibration Procedure

The module is to be calibrated to give 10cm deflection corresponding to a flow rate of 100 gallons/minute. A voltage output of 2.00 volts is required for the same scale.

An impeller flowmeter is used with a calibration factor of 1105Hz for 125gpm.
The corresponding frequency for 100gpm = (100/125) x 1105 = 884Hz.
The nearest calibration frequency on the M1085 is 500Hz.
The deflection for a 500Hz signal would be 10 x (500/884) = 5.65cm.
Preset the Controls as Follows:

M1080 Front Panel		
Shift Control		*
Range Switch		2kHz
Fine Gain		*
Tape Control		*
Run/Cal Switch		CAL
6-pole DIP Switch		
1	Optional Offset	OFF
2	Filter	OFF
3	Filter	OFF
4	Filter	OFF
5	Line Freq. Cal.	OFF
6	M1085 Cal.	ON
M1085 Front Panel		
Range Switch		OFF
Monitor Front Panel		
Range Switch		1.999
Ch. No./Cal. Switch		Ch. No.
Galvo. On/Off Switch		OFF
Channel		N
Bridge Voltage		*
Bridge On/Off		OFF
Calibrate +/OFF/-		*
Calibrate Fine		*
Calibrate Range		*

* Not important

N Corresponding to channel being calibrated.

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Note: On the M12-150 the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

1) Recorders only. Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

2) Set the Galvo. ON/OFF Switch to ON. Use the Shift control to adjust the voltage to 0.00V on the monitor. This should correspond to the spot at position 11 on the viewing scale. If not, repeat step 1).

3) Set the M1085 RANGE to 0.5kHz. Adjust the FINE gain control on the M1080 to deflect the spot by 5.65 cm on the viewing scale, i.e. Position 11 - 5.65 = 5.45.

4) Adjust the TAPE control to read 1.130V on the monitor.

5) It is useful to check linearity at this stage. Set the M1085 RANGE switch to 200Hz.
The deflection should be (200/500) x 5.65 = 2.26cm.
Scale reading = 11 - 2.26 = 8.74cm
Monitor reading = (200/500) x 1.130 = 0.452V

6) Set the RUN/CAL switch on the M1080 to RUN. The system is now calibrated and ready for use.

7) It is advisable to return the M1085 RANGE switch to OFF.

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